February/March 1987

AIR & SPACE

Smithsonian

Alan Bean paints the moon
with an astronaut's brushstroke

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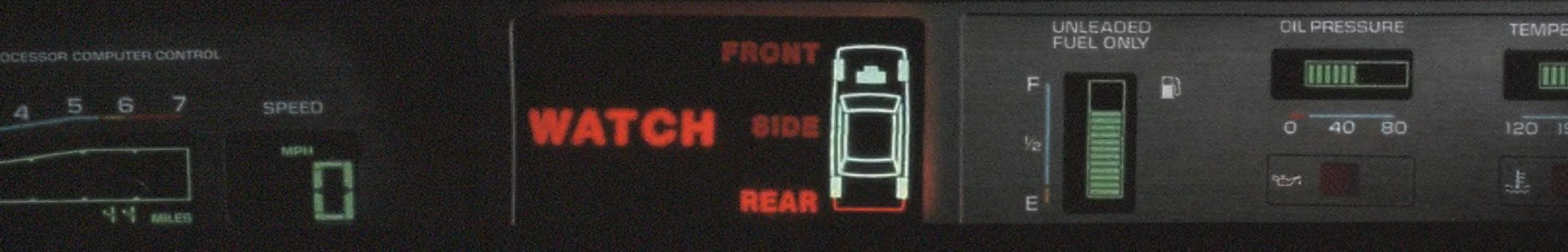

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AIR&SPACE
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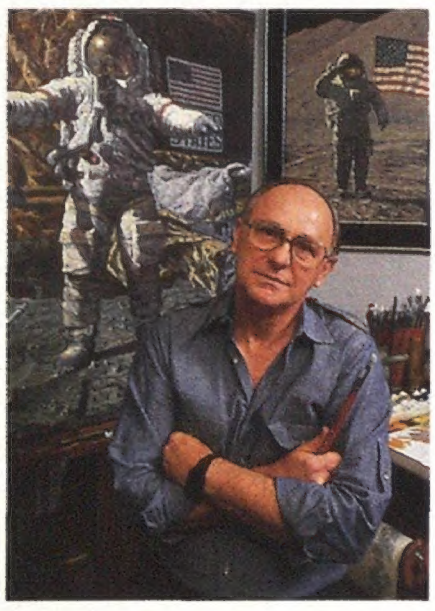
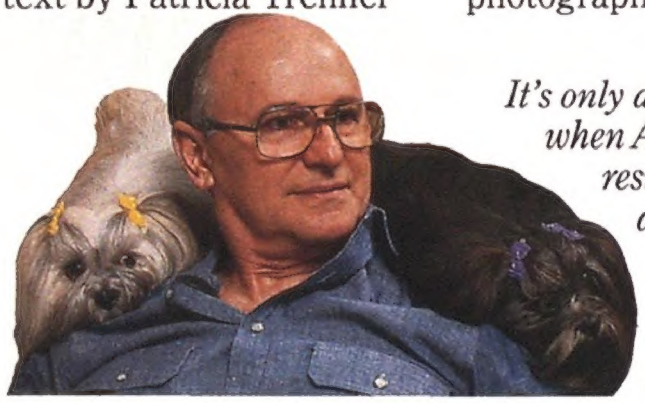
Cover: *David Nance photographed Alan Bean at work in his studio during a moment of reflection.*





AIR & SPACE/Smithsonian (ISSN 0886-2257) is published bimonthly by the Smithsonian Institution, 900 Jefferson Drive, Washington, D.C. 20560.

Subscription price $18 a year in U.S. possessions, $24 elsewhere. 85 percent of dues is designated for magazine subscription. Single copy price $3.50. Application to mail at Second Class postage rates is pending at Washington, D.C. and additional entry points. Editorial offices at National Air and Space Museum, Washington, D.C. 20560. Advertising and circulation offices at 420 Lexington Ave., New York, NY 10170. Members: Please address all subscription correspondence and change of address information to P.O. Box 53261, Boulder, CO 80322-3261. Postmaster: Send address changes to AIR & SPACE/Smithsonian, P.O. Box 53261, Boulder, CO 80301-3261.

Air and Space: A Common Legacy

A continuing flow of mail to *Air & Space/Smithsonian* questions the balance between air and space articles. These letters have been thoughtful; some have been helpful and others have provided humorous diversion.

But *are* "air" and "space" separate considerations at the National Air and Space Museum, or in the real world the Museum strives to represent? And are they treated equally, not only in this magazine, but in our research and exhibits?

While the two curatorial departments of air and space are administered separately, each has the same goals and responds to the same requirements for exhibits and research. Historians in both departments are specialists, tending to work independently of one another in their areas, and projects are based on individual strengths and interests, balanced by the needs of the institution.

The study of aviation, like the subject itself, is older and therefore more established at the Museum than space studies. Space historians are a newer breed and come from hybrid intellectual and technical backgrounds. But as the research of our air and space curators matures, more common ground for understanding the legacy of air and space flight becomes apparent. For the two are much the same.

The technology for the exploration of space grew mainly out of an aeronautical tradition. The National Aeronautics and Space Administration, which was formed in 1958, evolved largely from the pre-existing National Advisory Committee for Aeronautics, and the NACA centers for research in aeronautics—Langley in Virginia, Ames in California, and Lewis in Ohio—became NASA centers. Such pioneers in transonic aeronautical design as Robert Gilruth and Max Faget helped lead the effort to define and execute the NASA mission.

Major technological advances and the traditional methods of managing large technical enterprises, which emerged in the aviation industry, became the foundation for building the space program. As far back as 1946, when captured German V-2 rockets were tested by both the American and the Soviet military, the gears were set in motion to launch the world into the nuclear, supersonic, and space ages.

Since that time, most of the major figures in aviation have become pioneer aerospace contractors or participants: administrators, politicians, engineers, and scientists. With them rose the institutions, both social and technological, that shaped their professional lives.

In science there has been a continuum of effort: instruments for the study of the air and then space were flown first on balloons and kites, then on aircraft, and finally on sounding rockets, satellites, and space probes.

This continuum enables faster, higher, and longer flights with greater reliability, economy, and effect. It applies to both commercial and military worlds and certainly carries over into warfare, in which aerial reconnaissance was conducted from balloons in wars long past and is pursued now with the most sophisticated air- and spacecraft. And just as the methods of carrying bombs and weapons started in aviation, so is the capability brought to an operational (but hopefully stillborn) status in space.

Historians are keenly aware of this unbroken continuum between atmospheric flight and space flight. One cannot understand how space activity emerged at midcentury without a full appreciation of its aviation heritage. Counting the number of pages devoted to one or the other in any publication therefore becomes a superficial exercise that misses the point.

The point is that understanding the legacy of aviation in its fullest context better helps us understand our first few steps into space, and also helps us plan for a better future in space. Whereas the awesome and horrifying potential for remaking the art of warfare has been realized in aviation, we stand on the brink of its realization in space. Let the difference begin here.

—David DeVorkin
Curator, Space Science & Exploration Department, NASM

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Letters

Under Control

As professional air traffic controllers we feel that the essay "The Trouble with Air Traffic Control" (December 1986/January 1987) is not only the most inaccurate assessment of the air traffic control system we have ever read, but might more properly be classified as "fiction." It is our sincere hope that Mr. Foxworth is not as inept in the cockpit as he is in evaluating this nation's air traffic control system.

We feel that Mr. Foxworth should continue studying the history of radar and not address the current system until he is able to visit and observe the operation of a modern air traffic control facility. While our radar equipment is taxed by the volume of air traffic, it would be more accurate to compare it with *Star Wars* equipment than World War II early warning radar. Our radar interfaces with a computer that is larger than the system that put a man on the moon, and is in the process of being replaced by more sophisticated equipment.

Let it be understood, the nation's air traffic controllers are in control. We are dedicated to the safe and expeditious movement of air traffic through our nation's airspace. It should be noted that the controllers are tired of the inaccurate assessments of the air traffic control system by uninformed individuals or special interest groups. They are the ones who attempt to convince passengers that delays are caused by air traffic controllers. In fact, the airline marketing technique is the cause for the delay. When an aircraft arrives or departs every 12 seconds, the problem does not lie with the controller, but with the person who scheduled that many aircraft to occupy the same runway at the same time.
Gary A. Postlewait and *Greg P. Ryan*
Albuquerque, New Mexico

Hurray! At last an article concerning air traffic control (ATC) that makes sense. Thomas G. Foxworth knows what he is talking about. The situation will not be alleviated by using extra radar units or hiring any number of controllers until control is put where it belongs, in the cockpit. I agree that light airplanes are not the problem. In fact, there are easy ways to work small airplanes into the system, even in the busiest of airports, that will not interfere with airliners at all. The fact is that ATC, as it has been set up, is just not willing to take the trouble to do so. They simply wish to discourage private flying to make their job easier. I watched this system grow from the beginning when I was a pilot with a major airline for 39 years. I had misgivings from the first and have always thought that there was a better way.
Ned Wilson
Fort Davis, Texas

Thomas G. Foxworth replies:
The variety of responses reveals just how complex the ATC issue is. Predictably, the negative response was from air traffic controllers or those who lobby for them as a special interest group. It was inevitable that they should read only "threat" in what I wrote, and read no farther.

I have deep respect for them as individuals precisely because their present job is tough; I do understand their current constraints and frustrations. Neither the group on the ground nor the group in the air is being given the best tools or the best environment in which to get the job done. And that's the point. The system is sandbagging both of us.

Make no mistake: ATC is there solely to provide a service. To blame hub-and-spoke marketing for traffic delays because it overloads ATC is to beg the question. ATC must adjust to whatever scheme the user desires; indeed, it's up to ATC to make hub-and-spoke or any other scheme work. The user is king, and it's up to ATC to accommodate all users at all times.

Inevitably there will be delays. But if high technology provides us the means to introduce entirely new methods, to overhaul thinking, and maybe thereby to enable us to get more users inside expeditiously while keeping them better informed, it's time to employ it. Buttressing ground-based radar isn't

getting us any closer.

The first prerequisite is an open mind. I would ask my critics to reread not just my own essay, but all that has promoted such positive change. I did not attack them—just an entrenched and faltering institution.

How Do You Spell Tradition?

I was intrigued by "Space Geniuses Wanted: Apply JPL" (December 1986/January 1987); it brought back memories of my days at Cape Canaveral. I'd like to share a story of my encounter with JPL people over 20 years ago that is consistent with their demeanor as portrayed in the article.

I was working as a propulsion engineer for General Dynamics on the Atlas-Agena program during the 1960s. JPL was responsible for the satellite we were to launch. When the satellite arrived, so did the JPL crew with their beards, shorts, and sandals. In those days at the Cape they stood out as mavericks. Their appearance never became an issue until we started launch countdown simulations. Since publicity films were being shot during countdowns, attractive uniforms were the order of the day, even during rehearsal. The JPL people were apparently informed that they would have to conform to the dress code so that the movies would look nice. As the final countdown began the three JPL people who were to monitor consoles in the blockhouse showed up in white lab coats (over their shorts), walked in arm-in-arm and sat down side-by-side. On the back of each lab coat was a huge letter; from left to right it read J-P-L.

It seems that the current JPL folks are just as proud and individualistic as their 1960s counterparts. This is an encouraging sign in an increasingly bureaucratic world. I hope this letter brings back some memories for the people who were there.

Laurence S. Mannis
Winston-Salem, North Carolina

Correction

The *Challenger* disaster occurred on January 28, 1986, not 1985, as stated in the Calendar section of the December 1986/January 1987 issue. *Air & Space/Smithsonian* regrets the error.

Air & Space/Smithsonian *welcomes comments from its readers. Letters must be signed and may be edited for publication. Address letters to* Air & Space/Smithsonian, *National Air and Space Museum, Smithsonian Institution, Washington, DC 20560.*

Taking the High Road

As a youngster I lived in a fairly remote part of western Indiana. The gravel road in front of our house ran 200 yards to the west and ended at the Morris & Jack Greenhouses—strawberries, lettuce, and tomatoes in season, flowers year-round. But if you turned left out of our driveway, the gravel road changed into blacktop and followed the valley into town, where it joined the *real* roads—ones with official state numbers—heading everywhere.

I fidgeted with impatience until I was old enough to drive, waiting to turn left.

And I dreamed about the river that ran behind our house. What was to prevent a band of young explorers (naturally with me as the chief scout) from launching a boat and sailing down to the Wabash, over to the Maumee River, and right into Lake Erie—or, better yet, the Erie Canal? My friends and I had read about the canal and we loved hearing accounts of life on its boats and barges. Once on the canal there would be no stopping us as we pressed on to the Hudson River and then the Atlantic Ocean and finally the World. Now *that* would be an adventure.

I never made that river voyage. But I never lost my fascination with travel either. I have always admired the wonderfully ingenious mechanisms that humans have devised to get us there and back. It strikes me that our travel machines are the most tangible evidence we humans can point to in proving our uniqueness. It is difficult to discern a cause-and-effect relationship between cultures and inventions of mobility: Do the capabilities and nerve of a people determine their transportation methods, or is it the other way around? In either case, it is certain that history is shaped by transportation.

I remember that my first history book had chapters entitled "Along the Banks of the Rivers," "Along the Caravan Routes," and "Along the Shores of the Seas"—all transportation themes. The textbook ended with the prediction that mankind would someday master the poles and the stratosphere. Well, it *has* been a while since I started studying history.

Since then I have had the extraordinary privilege of flying aboard the space shuttle. The experience is exceptionally difficult to put into words. In spite of the shuttle's airplane-like appearance, being aboard as it circles the Earth is nothing like being aboard a hypersonic airplane in lofty flight. It is more like being aboard a ship; in fact, the word "spaceship" is exactly right for describing this remarkable machine.

There is none of the typical airplane noise—no steady drone of jet engines, no constant vibration of fuselage, floors, and seats. There is instead the reassuring and gentle hum of pumps, fans, and electronics, the occasional click of a valve, and the low hiss of nitrogen or oxygen being fed into the cabin to replenish escaped gases.

Nor does the shuttle move along its path like an airplane, which of course must always travel with its nose pointing forward. In orbit there is no air to dictate aerodynamics, so the shuttle coasts around the Earth pointed in every direction imaginable: sideways, backwards, or upside-down, as often as not. The crew manipulates the orbiter with an automatic pilot coupled to gyroscopes, as well as 44 rockets located in the nose and tail. Six of the thrusters are small enough to fit in your hand, and each has 25 pounds of thrust. These "verniers" are used for most of the flight and, despite their size, hold the 100-ton ship precisely in the desired position, an invisible anchor in the sea of space.

When crew members must change the shuttle's pointing direction rapidly or move it from one orbit to another, they call on the 38 primary thrusters, each of which can deliver 870 pounds of thrust. A tongue of flame shoots out several feet when one of them fires. And if the thruster is on the nose just outside the windows, you hear a sound like a cannon going off. A primary thruster on the tail, some 60 feet away from the crew compartment, sounds more like the "whump" of a mortar shell being launched. The orbiter shakes noticeably with each salvo and moves accordingly. Performing a series of maneuvers using the primary thrusters must surely be like being aboard a 19th century fighting ship.

And then there is the perpetual floating, which feels like nothing on Earth. I have read that Columbus' crewmen were worried that he would have them sail right off the edge of the world. Our spaceships do just that. A shuttle flies to the edge of the Earth and some 300 miles beyond, then falls around the planet in an endless orbit. But the sense you get isn't of falling. Instead, everything within the ship—checklists, pencils, cameras, socks, toothbrushes, and midafternoon snacks of cookies and juice—floats. "Zero G" we call it, but that's just space jargon for floating.

In zero G, you can squeeze orange juice from its plastic container and watch the juice coalesce into a shimmering, quivering sphere that hovers before your eyes. Puff gently on the edge of the sphere and miniature waves roll around on its surface. A sharper puff aimed at the center breaks the sphere into two smaller globes that separate in slow, quaking motion.

This absence of up and down has intriguing technical consequences that go far beyond containerless fruit juice. For example, substances that have vastly different weights or densities on Earth and that therefore separate under the force of gravity become compatible in the weightlessness of space. Helium can be evenly mixed with mercury, feathers with lead. In the wonderful workroom of zero G, a modern blacksmith could mix air bubbles with molten metal to whip up a meringue with the strength of steel but the lightness of balsa wood.

Even sleeping is different in zero G, since it makes no sense to "lie down." In fact, you just close your eyes and sleep, letting your arms and legs float in whatever bizarre positions your relaxed muscles give them. Unfortunately, currents from the air conditioning system sooner or later push the contented sleeper into areas where others are trying to sleep—or work.

On shuttle missions that require round-the-clock work schedules, we avoid such interruptions by using small sleeping compartments that resemble the bunks of a Pullman car. On other missions we use simple "sleep sacks" equipped with tethers

at both ends, which can be tied to small hooks in the crew compartment. Going to sleep consists only of fastening the ends of the sack wall-to-wall or floor-to-ceiling, zipping yourself in, and closing your eyes. You float within your hollow hammock, which in turn floats within the spaceship.

You sleep, but not necessarily without interruption. Suddenly, you are awakened by inexplicable gyrations. Slowly you realize that your subconscious has been instructing the muscles of your arms and legs to turn over, and your limbs are thrashing about, trying awkwardly to accomplish the assignment. Your conscious mind now tells you that turning over has no purpose in a floating environment. You smile at this earthling's reflex, go back to sleep—and 20 minutes later wake up doing the same thing.

Finally, there is the view of the Earth itself, far grander than any ever seen from an airplane window, filling the shuttle's windows. You orbit in your space gondola and watch the oceans and islands and green hills of the continents pass by at five miles per second. In fact, it's hard to reconcile the spaceship's breathtaking speed with the inescapable fact that you are floating within it. You don't sit before the window to view the passing scene; you float and look *out* on the scene, certainly not *down* on it. Are you speeding past oceans and continents, or are you just hovering and watching them move majestically beside your window? The answer doesn't come naturally to an Earth-trained mind.

What I find even more difficult than putting this experience into words is trying to catch the essence of Americans' traveling out to the space frontier. This is particularly hard now, in the midst of the soul-searching and backward-looking debates following the tragic loss of the *Challenger* and her crew. But we all must think about these journeys from Earth, occasionally even while sitting on the bank, gathering up the courage to plunge back into the stream.

Richard Truly (left) and Guion Bluford offer differing views on sleeping in space. NASA

Some people argue that we have already reconnoitered the solar system with unmanned spaceships and we now know pretty much what's out there. Our advanced robot scouts show Mars and the other reaches of our solar system to be barren and inhospitable. So why go? The argument at first seems reasonable. Had we applied the same reasoning to deciding whether to explore Alaska or the Antarctic, we probably would be very smug today because we saved money and lives by not sending explorers to such hostile regions. What about economic return from these wastelands? Perhaps we were just lucky with Alaska. But while the Antarctic has not yet provided a substantial return on our investment, will it still be considered a worthless wasteland two generations from now? I wouldn't bet a nickel on it, much less this nation's future.

We've heard "Let's not go" before. Even Thomas Jefferson, as keen as he was on acquiring real estate for America, waffled when it came to bold plans for transportation networks to bind the vast territory. Confronted with the idea of building a canal linking Lake Erie with the Hudson River, he mused, " . . . a canal three hundred and fifty miles long through a wilderness. It is a little short of madness to think of it at this day!"

But the Erie Canal was completed in 1825, and over the decades it added immeasurably to America's prosperity. It also created a mystique and a sense of direction that captured the imagination of youngsters for over a century and at least as far away as Indiana.

Think of the young imaginations that the exploration of space—human ventures in the face of risk and desolation—will have captured a mere hundred years from now. The real risk lies in endlessly arguing, worrying, and just sitting on the bank.

—Joe Allen

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Perlman: Mozart, Violin Concertos Nos. 3 & 5 Vienna Philharmonic/Levine. "Radiantly sumptuous."—High Fidelity DG *DIGITAL* 115146

America, The Dream Goes On The Boston Pops/Williams. Title song, *America, Battle Hymn Of The Republic*, more. Philips *DIGITAL* 115134

Handel, Messiah (Highlights) Musica Sacra/Westenburg. *Hallelujah Chorus, I Know That My Redeemer Liveth*, more. RCA *DIGITAL* 153586

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Alicia de Larrocha: Falla, Nights In The Gardens Of Spain Also includes rhapsodies by Albéniz & Turina. London *DIGITAL* 115410

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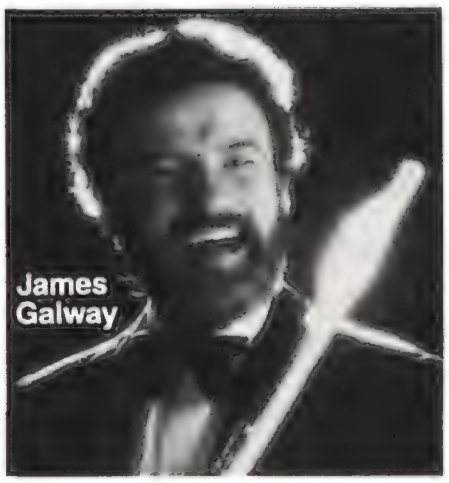

Artur Rubinstein: Chopin, 14 Waltzes "[His] playing is relaxed, assured, and wonderfully controlled."—American Record Guide RCA 101987

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Kiri te Kanawa: Blue Skies With Nelson Riddle: Title song, *Speak Low, How High The Moon, So In Love,* 8 more. London *DIGITAL* 115035

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Flying the Oregon Trail

Illustrations by Paul Salmon

Five hundred feet below, the vast midwestern prairie rolled under the tiny Aeronca Champion. Every few minutes, pilot Maurice Brett checked the strip map he created at his home in Baldock, England. With it, he could locate the Oregon Trail to within a few hundred yards.

In the mid-1800s the Oregon Trail served as the pathway west from Independence, Missouri, for nearly half a million emigrants. The 2,170-mile trek through Kansas, Nebraska, Wyoming, Idaho, and into Oregon attracted fur traders, gold seekers, and missionaries, but most of the pioneers were farmers seeking a better life in the Willamette River Valley and other locations in the Pacific Northwest, an area with some of the most fertile farmland on the planet. The risks in making the journey were great—an estimated 30,000 to 45,000 perished, about 1 in 10. Others later died in massacres, as did the inspiration for Brett's flight, Narcissa Whitman, who was killed with her husband by Indians 11 years after their journey's end.

After driving most of the route during several vacations, Brett joined the Oregon-California Trails Association in 1985. He then read an 1836 account of the Whitman party, a trip that revealed to Easterners that it was possible to travel to the Northwest by wagon. Narcissa Whitman's letters to friends back home and her death at the mission she and her husband founded at Walla Walla, Washington, so moved Brett that he set out to document from the air the vestiges of the trail.

On July 23, 1986, nearly 150 years after the Whitmans' trek, Brett and several companions from the Stevenage Flying Club in Biggleswade, England, set out from

Rushville, New York, where the Whitmans had departed during a February snowstorm. With Brett as pilot, one crew member flew as navigator and cameraman; the others followed in a car as ground support. By August 4 Brett was in Oregon City, the western terminus of the trail, after a 12-day flight with stops at 80 airports. The Whitmans' journey had taken nearly eight months.

The 1949 Aeronca proved an ideal camera platform, flying low and slow like the open-cockpit Tiger Moth that Brett had used to document old Roman roads in England. Brett's 42-foot-long map, an ingenious combination of Oregon Trail data and present-day aeronautical charting, laid out the trail on a scale of one-quarter inch to the mile. From time to time Brett would bank the airplane so the back-seater could photograph with a 35-mm camera and film with a movie camera. An additional still camera was mounted on a wing strut and activated by remote control from the cockpit. The photo mission resulted in 1,200 slides and 1,000 feet of film.

More than a hundred sites, including the Whitman mission, have been preserved by the National Park Service to commemorate the trail. Though most of the route has yet to be marked, it is easily distinguished near landmarks like Chimney Rock in western Nebraska.

In some spots the weight of 50,000 to 100,000 prairie schooners cut so deeply into the underlying limestone that the rutted trail is still three feet deep. Even where the path is less clear, the wagon wheels so compacted the soil that decades of cultivation can't eradicate the differences in how the subsoil absorbs moisture. Today, vegetation over the ruts is either darker or lighter than the surrounding growth, depending on the amount of water the soil absorbs.

There are portions of the trail, Brett says, that in fact seem fairly pristine. Miles of ruts are visible along two Idaho segments, Soda Springs to Fort Hall and Three Island Crossing to Fort Boise. These sites are so removed from cities that they have yet to be crossed even by four-wheel-drive vehicles, and the swells in the ground that roll across the sea of land match the trail's map exactly.

Now back home in Baldock, Brett is working on two books about the trail and his flight, as well as a video documentary called "The Oregon Trail Today." The proposed three-hour length will be barely adequate to express the sense of distance and varying terrain of the prairies Brett has grown to love. But the human story is what really hits home. Of the pioneers, Brett concludes, "I just don't know how they did it. I'm lost in admiration."

—Dave Hughes

Resorting to Astronomy

Just imagine the vacation snapshots you'd bring home: rather than color prints of Disneyland, you'd be showing off slides of the Crab Nebula, the large Magellanic Cloud, and the Pleiades. Even if the only sky watching you've done is to check for

rain, you might decide to cultivate an interest in astronomy for your 1989 vacation. That's the target date for the opening of The Observation Point, or TOP, on Granite Peak in the Hualapai Mountains of Arizona.

Some of the best stargazing in the world can be had in the mountains of the western United States, but spending a few nights in the desert requires considerable sacrifices in creature comforts. But Thomas R. Kelly, the driving force behind TOP, is not talking no-frills stargazing here—he's talking steam baths, jogging and nature trails, tennis ranch, golf course, and Olympic-sized pool. And in your own Observatory Suite, a wet bar, stereo, and built-in telescope on the balcony.

Kelly and business partner Robert B. Thelander are relying on some 28 million Americans with an interest in astronomy to make a success of their $40 million resort, which they describe as a merging of science and tourism into a "scientific Disneyland."

Interest in astronomy and space travel is riding a wave of public enthusiasm that hasn't been seen since Kennedy's "last frontier" era. Hollywood cranks out one space movie after another—*Star Wars, E. T., Aliens, Star Trek IV.* Congress invites Carl Sagan to lobby for sending a mission to Mars. Comet Halley pays a well-attended visit (albeit a disappointing one). Many observatories, unable to handle the crowds that clamor for a look through their telescopes, regularly turn people away. All tell the same story: there are more eager viewers, professional and amateur, than there are telescopes to accommodate them. "Telescopes are like airplanes," says National Optical Astronomy Observatory (NOAO) spokesman Carl A. Posey. "There are always more pilots than planes."

Kelly's solution is a "jewel of the Arizona tourist facilities" 30 miles south of Kingman, with 250 guest rooms, professional observatory, 200-seat planetarium, photo lab, and 280 cloud-free days a year. The pièce de résistance of the professional observatory, 7,000 feet up the mountain, will be three reflecting telescopes, ranging from 39 to 82 inches, available to both pros and serious amateurs for research and photography. (Plans also call for a radio telescope.) The proposed sizes appear to be large enough to interest many a graduate student who may have trouble securing time on large instruments elsewhere. Kelly points out that in 1985 three out of four professional astronomers could not get into the NOAO's Kitt Peak facility. (TOP's proposed site was originally NOAO's second choice for its observatory.)

Meanwhile, back on the ranch at the base of the mountain, visitors will be able to book a Galaxy Suite, complete with a 16-inch reflector operated by a user-friendly computer (dial up M-13 and the telescope will move to the appropriate star cluster in the constellation Hercules). For those on a budget or who prefer to BYOE—bring your own equipment—plans call for rooms with balconies and power sources for motor-driven cameras. Hardier souls in RVs can set up at a mountainside site that has a concrete pad and a built-in power supply. For those unfamiliar with the equipment, or the sky, lectures will be given during the day and a video system will provide continuous instruction. You'll be able to rent just about anything, including eight-inch telescopes, tripods, cameras, and power drives. And after sunset every night, visitors will be invited up the mountain to watch the pros at work.

TOP sounds like an amateur astronomer's dream, but will it fly? The numbers look good—in 1983 Arizona drew nearly seven million tourists who spent

more than $2.1 billion. But to succeed, the resort must be carefully packaged and presented to the pros, who can be somewhat skittish about using facilities open to the public. Kelly and Thelander may have to scale down some of their more grandiose plans, but for now they are undaunted. "The public is becoming more sophisticated," Kelly says. "They're ready for this. If Meteor Crater can attract 200,000 people in a single year, we can do at least that."

—Gail S. Cleere

Concrete Ideas

William Agosto has a dream. He wants to manufacture concrete on the moon.

Now, as anyone who has put in a backyard patio knows, you need water to make concrete. And as Agosto, a former Lockheed scientist, says, "The moon is one of the driest things we've come across." On the other hand, there's plenty of oxygen inside the rocks on the lunar surface and hydrogen in the soil, and technology is being developed that could enable scientists of the 21st century to extract the oxygen, combine it with the hydrogen, and produce moon water.

Agosto foresees his dream as a wise economic move for the space program, particularly in light of the space station planned for the mid-1990s.

"Some people think I'm absolutely nuts," says the founder and president of Lunar Industries, a Houston-based company that has no laboratory, no government contracts, and, after two years in business, no income. "But with the moon's reduced gravity, making cement and shaping structures up there would be a cheap way to get them into space without having to launch prefabricated units from Earth."

Agosto's ideas for making the moon a manufacturing facility are seconded by Michael Duke, chief of the solar system exploration division at the Johnson Space Center in Houston. "For every pound of payload you deliver to the moon, you start with seven pounds of rocket and propellant," Duke says. "The space shuttle's current payload is only about 1.5 percent of its total mass at liftoff, but when launching from the moon it should be possible to have half the shuttle's mass spent in payload."

Duke also thinks the moon would make a better space colony than would a floating station, because humans will be more comfortable working in the moon's one-sixth gravity than in zero gravity.

"In less than a decade you could pay off the cost of establishing a lunar base, by way of reduced transportation requirements for materials and oxygen from Earth," says Agosto. "The shuttle uses oxygen and hydrogen for liftoff, so some of the oxygen produced on the moon would be used for fuel."

Agosto plans to create the oxygen necessary to make water, and subsequently concrete, by vaporizing lunar rocks in a solar furnace (a process he may also market on Earth to dispose of PCBs and other hazardous wastes), and he sees moon-derived concrete structures as ideal for protecting colonists from cosmic rays, micrometeorite showers, and temperatures ranging from 200 to minus 400 degrees Fahrenheit.

Agosto isn't the only entrepreneur interested in making concrete on the moon. In fact, T.D. Lin of the Portland Cement Association in Skokie, Illinois, has already produced a laboratory version of lunar concrete. Lin's recipe called for water, cement, and 1.4 ounces of lunar soil obtained from the National Aeronautics and Space Administration instead of the usual sand-gravel mixture. What it produced was a one-inch cube of concrete that proved to be considerably stronger than the homemade variety.

"We measured its compressed strength at 10,971 pounds per square inch, compared to 7,900 psi for a comparative sample of conventional concrete," says Lin. "Since the minimum standard for a reinforced concrete slab is 4,000 psi, the results of the lunar soil mixture were very encouraging."

Anyone who's burned a steak in a microwave oven will appreciate University of Tennessee scientist Tom Meek's idea for developing lunar-based construction materials. "Envision a lunar rover pulling a magnetron—a high-power microwave generator—that contains the same kind of traveling-wave tube that's in every household microwave oven," says Meek, a former staff member of the Los Alamos National Laboratory. "We focus that microwave energy one foot into the lunar soil and heat it to about 1,000 degrees Centigrade, fusing the soil particles. When the surface cools, it's strong enough to be used as a road—or cut up and used for construction materials."

The fate of Agosto's singleminded Lunar Industries depends on whether NASA officials decide to fund an experimental concrete manufacturing operation on a future shuttle flight. But regardless of the outcome, Agosto says being involved in space technology has shown him a host of opportunities.

"We could build larger power plants that would orbit the Earth and provide us with solar power in the same way satellites provide us the means to transfer information," he says. "Or we could take several billion tons of natural iron from the top four inches of lunar soil and use it for powder metallurgy. You could press it into tools, beams, gears, electrical contacts, or Swiss Army knives. Anything you want—it's there, just waiting for us."

—Kent Hannon

Answering Airport Prayers

It could have been a gathering of sales reps or accountants—most of the men were in sport jackets, and the women wore conservative dresses and suits. But the occasional clerical collar and the conference site—the Priory of Our Lady of Good Counsel—indicated that this was a group with a higher calling.

The 19th conference of the International Association of Civil Aviation Chaplains brought 48 members to a peaceful location in Hassocks, 15 miles from London's Gatwick Airport, early last October. Though the organization has a low profile, its members come in daily contact with a sizable fraction of the 1.8 billion travelers who pass through the world's airports every year.

The attendees represented about 35 percent of the men and women, both lay and clergy, who hold chaplaincies at 54 airports in 28 countries in Europe, Asia, and North and South America. They came to Hassocks to share their approaches to the unique problems they face in providing the spiritual, moral, and in some cases practical assistance their flocks require.

Most airport chaplaincies were established by various Christian denominations, but there is a Jewish chaplain at New York's Kennedy Airport. Furthermore, some chapels have prayer rugs installed for Moslems, and the chapel at Hartsfield International in Atlanta contains a compass that orients worshipers toward Mecca.

"We are completely nonsectarian and serve as a welcoming facility for people of every race, language, and creed," says association president Father John Jamnicky. His parish is the sprawling Chicago O'Hare International Airport, a thriving minicity of 40,000 employees and 55 million travelers who pass through the airport every year. Jamnicky sometimes uses a golf cart to traverse the terminal corridors.

The chapel (phone 686-AMEN) is hidden off a basement corridor in Terminal Two, amid a clutter of overhead pipes and wiring. Every day, Jamnicky listens to the social, religious, and economic problems that plague his visitors: panic-stricken passengers who have lost their tickets, airport employees with drug, alcohol, job, and marital difficulties, and the rising number of individuals who have nowhere to go and literally call the airport home. There is also the occasional marriage ceremony, and the tragedy of an airliner accident.

Jamnicky thrives on his work and his environment. "In my five years here, I've been associated with the happiness of births and the grief that accompanies death," he explains. "What I love about the airport is its life, its humanity. There's a kind of energy field here that feeds people—you get caught up in it, and you miss it when you aren't there."

Airport chaplains the world over share Jamnicky's concerns and enthusiasm, but recently, chaplains at Frankfurt, Amsterdam, Brussels, and other European airports have faced a new problem—an influx of religious and political refugees from Asia, Africa, and the Middle East.

For example, Karl Guterlet, a Protestant chaplain at Frankfurt's Rhein-Main Airport, spends a great deal of his time with refugees from the Armenian Apostolic church in Iran. As at other European airports, refugees often arrive without proper documentation and must remain at the airport or in nearby refugee camps until their political status and ultimate destination can be determined. During that process, which can take a few days to a few months, "Father Karl," as the refugees call him, walks a diplomatic tightrope in attempting to sort out the refugees' problems with the German border police.

But all is not trouble and strife for airport chaplains—the occasional amusing situation lightens the load. Reverend Jan Hoogervoorst, a chaplain at Amsterdam's Schiphol Airport, says he was once obliged to tell a young couple to move on because their romantic pastime in the chapel was not an appropriate form of worship.

Even the threat of terrorism has its lighter moments, says Father Brian Laycock, a chaplain at London's Heathrow Airport. Laycock was chatting with a group of businessmen in a cocktail lounge when a security guard repeatedly warned them of the possibility of a bomb in the vicinity. Laycock's companions, unimpressed, continued their drinking. "Not to worry, officer," one of them told the guard. "We're with the padre."

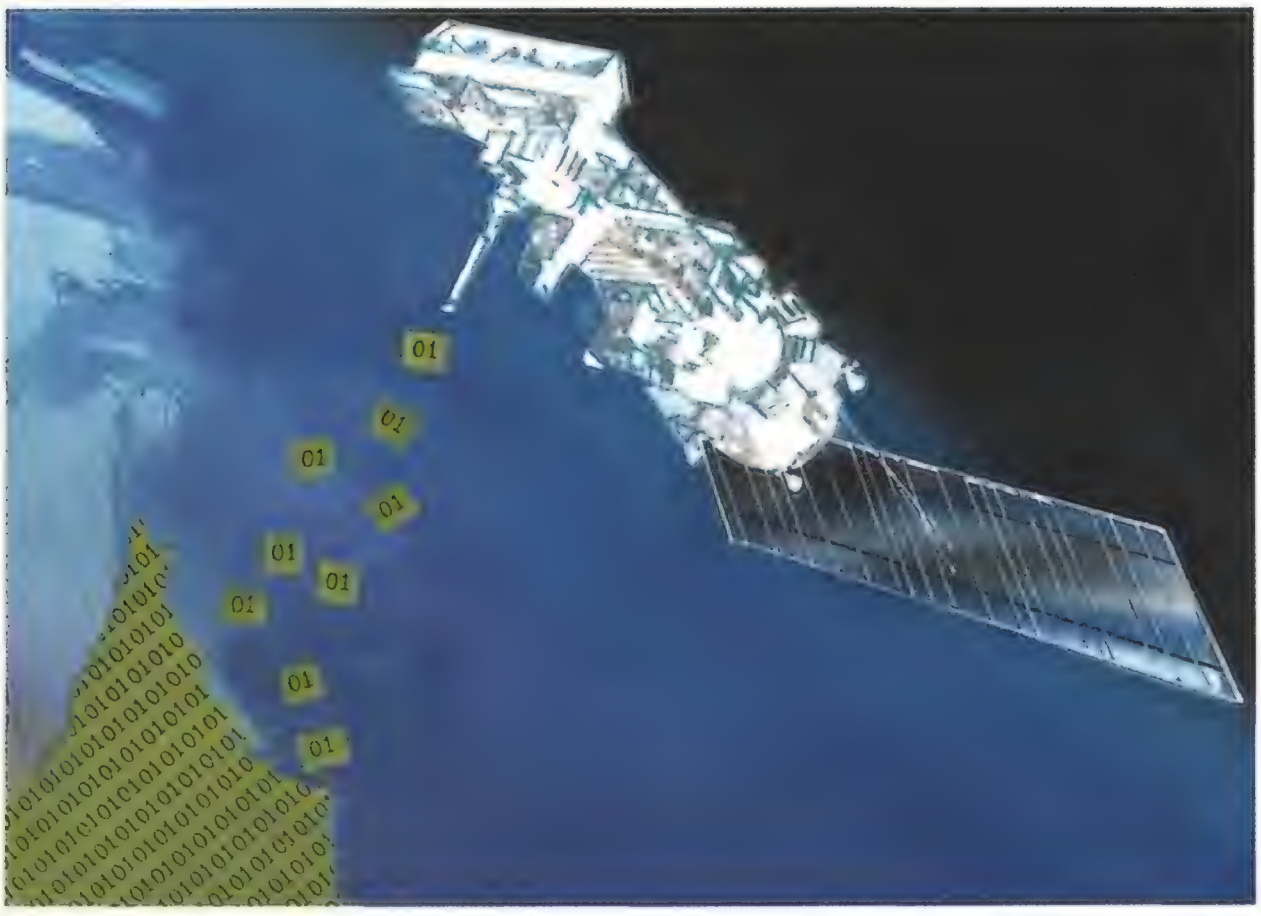
—John F. Henahan

A Nation on Tape

It's hard to get a good picture of the face of the Earth. Lighting is a problem, and so is stepping back far enough. What's worse, the subject is usually hidden by clouds. But that will change this summer, when the U.S. Geological Survey (USGS) unveils a new cloud-free portrait of the country.

The picture will be a composite of 15 to 20 overlapping images from National Oceanic and Atmospheric Administration (NOAA) weather satellites. The images are made not by cameras but by sensors that measure visible light and infrared radiation emanating from the ground. These measurements are compiled on digital computer tapes, sorted by computer to eliminate cloud cover, and assigned to a standard map projection. Each sensor reading represents a little more than half a square mile; 18 million readings cover the continental United States.

Putting the nation on tape is the goal of geographers, geologists, and other scientists engaged in land and resource management. NOAA already uses the readings to measure mountain snow cover and predict spring runoff, monitor volcanoes, floods, and fires, and trace fault lines. NASA analyzes the data to detect chlorophyll, which allows scientists to track the "green wave" of new vegetation across the country in the spring and the brown



wave in the fall. Besides enabling an estimate of crop productivity, chlorophyll levels indicate to the Bureau of Land Management the risk of forest or range fires and reveal to the Soil Conservation Service levels of ground moisture and the spread of deserts.

The computer mosaic of satellite images offers a nationwide base for these studies and for comparisons with future information. It also makes a nice picture. Printed in simulated natural colors or displayed on a monitor, it realistically depicts the physiography of the country, with mountains, deserts, forests, rivers, and cities clearly visible. "It's pretty hard to look at maps and really understand the terrain," says Fred Brownworth of the USGS, who believes the image will make geological features easier to recognize. "God neglected to paint the Earth with contour lines."

That was left to the cartographers. The USGS has on computer tape thousands of maps showing contour lines, as well as county boundaries, roads, bodies of water, and administrative districts. The computer image of the country has been fitted to the standard 1:2,000,000-scale political map. The mosaic could also be overlaid with vegetation or soil classifications, images from other satellites—to put the clouds back in, for example—or cultural information, such as population figures.

The U.S. Forest Service, for example, needs simultaneously overlaid maps of surface topography, land ownership, timber value, and forest fire potential. And it needs them while a forest fire burns and the reconnaissance airplane is measuring ground temperatures with a remote sensor.

"The forest service is exceptional in needing real-time information," says J. David Nichols of the Jet Propulsion Laboratory in Pasadena, California. Nichols recently completed the design of a new mapping system for the forest service. In the old system, aerial temperature readings were delivered upon landing—or dropped from the airplane—and hand-carried to cartographers. In the new system, all maps go up with the airplane, stored in the on-board computer. The computer monitor displays the maps and automatically overlays the new thermal information, revealing the extent and probable course of the fire. The maps are continually updated to reflect the airplane's position without any help from the pilot: the navigation information feeds into the map display. This system speeds up decisions on managing a fire—hence the name Forest Fire Advanced System Technology, or FFAST.

But airplanes aren't the only vehicles in the fast lane. The major car manufacturers have demonstrated similar systems to help motorists. A dashboard-mounted computer screen displays a stored map and tracks the car's progress along it via compass and motion sensors. Ford's screen, at the touch of a finger, will also display estimated mileage and fuel consumption. In the 1990s, GM drivers may plan their itineraries online—or let their Corvettes do it for them.

Taped maps and images—in cars, airplanes, and home computers—may one day replace paper charts altogether. After all, they can be stored in a space smaller than a glove compartment, they eliminate clouds and back-seat drivers, and best of all, they never need to be refolded.

—Joanne Heckman

Space Construction: Winging It

It's not the ideal way to start a construction project: the blueprints keep changing, the schedule keeps stretching, there's currently no way to get materials on site, and the budget is pretty shaky. But the location is firm—low Earth orbit—so the National Aeronautics and Space Administration is forging ahead with plans for a space station in the next decade.

The agency has had only one chance to try out a space construction technique in orbit—during shuttle mission 61-B aboard *Atlantis* late in 1985. The demonstration was called EASE/ACCESS, an acronym that perhaps NASA created first and filled in the words for later: it stands for Experimental Assembly of Structures in Extravehicular activity/Assembly Concept for Construction of Erectable Space Structures. The EASE/ACCESS experiment was a big success, and it's a good thing; NASA may not do any more extraterrestrial experimentation before space station construction begins.

Some NASA people say the lack of a final design for the space station is no problem at all. "A primary feature of the plan has always been a lack of design requirements," says Martin Mikulas, head of the structural concepts branch at NASA's Langley Research Center in Hampton, Virginia. Mikulas, who has been developing space construction methods since 1974, before NASA had a shuttle, let alone a space station program, says, "The structure is designed for growth and change"—a kind of built-in ambiguity and obsolescence factor.

At a NASA conference last August at Langley that brought together engineers to review EASE/ACCESS results, the crowd did not want to dwell on the grounding of the shuttle fleet, the reduced number of orbiters, and the efforts to chip away at space station funding. They wanted to talk about how EASE/ACCESS proved that a space station can be built in orbit. And that's what the EASE/ACCESS astronauts were there to tell them.

During the seven-day mission, Jerry Ross and Woody Spring, working in the cargo bay, assembled ACCESS, a 45-foot tower, in 25 minutes, and EASE, a clumsy-looking multiple-sided structure, in 9 to 13 minutes. (EASE took so little time to put together that the astronauts assembled and

The second of three Australian communications satellites is now in service. Aussat 2 was launched from the space shuttle into geosynchronous orbit, 22,300 miles above Earth. After completing three weeks of testing in space by Hughes Aircraft Company, the Hughes satellite was turned over to Australia for operation. Aussat spacecraft are designed to unify the Australian continent and off-shore islands. Each uses three-reflector antenna systems, which produce seven transmit beams for regional and national coverage. The satellites carry direct television broadcasts, telephone service, digital data transmission, and provide centralized air traffic control.

Dangerous hot spots that could flare up after a forest fire can be located by rangers. Inspections are made by aiming a hand-held Hughes Probeye® infrared viewer while flying over the area in a helicopter. The Probeye viewer sees heat the way a camera sees light, converting it instantly into an image seen through the eyepiece. Additionally, mining officials report success using Probeye viewers to prevent fires, to search for lost or injured miners in smoke-filled passages, and to inspect structures, electrical systems, and mechanical equipment. The infrared viewer also detects concealed fires and potential spontaneous combustion sources, such as hot spots in coal beds and refuse dumps.

An automatic infrared test and diagnostics system inspects printed circuit boards more quickly and at less cost than conventional methods. The THERMOSCAN system uses a non-contact approach to test a variety of printed circuit boards and hybrid circuits. It can be used on production lines, repair depots, or intermediate repair facilities as a complement to automatic test equipment or as a screening and testing device for repairable boards. The system thermographically tests several good boards or hybrids and stores a standard temperature profile in computer memory. The unit under test is compared by the computer to the stored thermal profile, and differences are displayed on a screen. Suspect boards can be tested at a rate of up to 30 per hour. The Hughes THERMOSCAN system detects most component failures on printed circuit boards and hybrid circuits in a single test.

Cable TV subscribers in Northern California will get improved service with a new microwave system that distributes 40 channels from one centrally located site, near Davis, to hub sites in four non-contiguous communities. The new Amplitude Modulated Link (AML) system, developed and built by Hughes, makes it feasible to cluster Woodland, Winters, Dixon, and West Sacramento, each ranging in size from 900 to 13,000 homes, into one system serving nearly 30,000 homes. The array handles video, FM radio, and signal control data without the expense of cable trunks and other equipment and building facilities. Sonic Communications, the second-largest independent operator of multiple cable TV systems in California, expects that the system will bring both capital cost savings and operating economies.

Hughes' Santa Barbara Research Center is seeking experienced engineers and scientists to further develop advanced IR systems. We need design engineers, nuclear effects engineers, instrumentation engineers, electro/optical packaging engineers, IR system analysts, and project leaders. To learn how you can become involved in the development of new IR systems, contact the Santa Barbara Research Center, Professional Employment, Dept. S2, 75 Coromar Drive, Goleta, CA 93117. Equal opportunity employer. U.S. citizenship required for most positions.

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disassembled it several times, like kids with a giant Tinker Toy.) Ross and Spring worked from several positions: clamped in foot restraints in the cargo bay, tethered to the bay's sides, and strapped onto the shuttle's robot arm. "The assembly work was very easy," Ross told the conference, though he admitted that the muscles in his hands and forearms tired from trying to hold his body in place. Suited up, the astronauts weigh about 400 pounds each on Earth; in orbit they're weightless, but they do have mass, and expend a lot of energy controlling their movement. Still, they accomplished their EASE/ACCESS chores in space 18 percent faster than they did during training in a "neutral-buoyancy tank"—NASA's term for a custom swimming pool that simulates zero gravity.

The astronautical construction workers will be on their own up there, with no Occupational Safety and Health Administration or construction union to look out for them, so the astronaut office has established some guidelines for space construction work. Space suits need further improvements. New gloves were provided for EASE/ACCESS, but the astronauts still got numb thumbs an hour into the job, and the numbness persisted for more than a month. Another problem is low temperatures, which render the suits inflexible. A session outside the shuttle can be slated for six hours every other day for one week, but not during the first three days of a mission, when space sickness might occur. Finally, manned maneuvering units, the jet-powered backpacks made famous by the photos of astronaut Bruce McCandless drifting from the shuttle like an armchair alien, would not be used because they are designed for transport and are too cumbersome to wear while stationary.

The astronauts would like a larger neutral-buoyancy tank to prepare for space construction work, since mockups of space station components will be too big to work with in NASA's current tanks. Kitty Havens, a Johnson Space Center crew trainer who prepared Ross and Spring for EASE/ACCESS, agrees: "There are no plans for a new tank, and I don't know how we'll do our work without it."

Suggestions for shuttle-borne construction experiments are still floating around NASA. Mikulas favors an expanded version of the Long-Duration Exposure Facility, an unmanned laboratory carrying various ongoing experiments that was launched in 1984 and is still in orbit. Astronauts could assemble such a structure in orbit, Mikulas says, and use it to house similar experimentation. The Goddard Space Flight Center is building a robotic system for an in-orbit demonstration of automated construction, and officials at NASA headquarters are considering a bigger role for robotics in assembling and maintaining the space station and servicing spacecraft, platforms, and payloads. But the odds of further experimentation getting off the ground before space station construction begins are about fifty-fifty.

While NASA managers worry about time and money, engineers and astronauts plow ahead with preparations for the space station era. "I don't worry about the shuttle schedule that much," Mikulas says. He believes that unmanned launches can handle many of the payloads originally planned for the shuttle, freeing it for space station jobs. "I don't see any delays in the program," Ross told the conference, cool and confident in the face of constant change.

—Linda Billings

Request for Proposals

Motorists on Interstate 880 in Oakland, California, are often given an aerial sneak preview. Daily, sometimes hourly, they see Milo Tichacek's blue and yellow Stearman biplane climbing out of Oakland Airport's north field, unfurling a 100-foot-long banner behind it. And while Tichacek is en route to Candlestick Park or the morning traffic jam to deliver a message, they get to read it first: "All The Sugar And Twice The Caffeine—Jolt Cola" or "Jenny Will You Marry Me? Love, Joe." Thousands of total strangers knew San Francisco 49er Joe Montana was going to propose before his future wife did.

Tichacek, a 58-year-old native of Czechoslovakia and a confirmed bachelor, may be the busiest matchmaker in the state. Last year he delivered 40 lofty marriage proposals. In the spring, business was so brisk he didn't bother to disassemble the "Will You Marry Me?" banner—he just changed the names. Once he was even called in to tow an apology. "I'm Sorry," it read. "I Love You. Forgive Me." And to think, some people just send flowers.

Last spring a reporter noticed the undue number of wedding proposals flapping overhead and became suspicious. She accused Tichacek of flying fake proposals as a publicity stunt. "Why would I want to do that," he asked, "when these guys are willing to pay for a real proposal?"

Tichacek's fees are based on an hourly rate of $220, and he'll tow any message (*sans* profanity) up to 40 letters within hundreds of miles of Oakland. And while he can't guarantee an "I do," he can guarantee high visibility. During rush hour, for example, he figures that in two hours he's seen by half a million commuters in the San Francisco Bay area. And flights over stadiums in Berkeley, Stanford, Oakland, and San Francisco guarantee a captive audience of thousands.

Tichacek's flying career began in 1946, when he flew Siebel Si-204 utility aircraft in the Czech air force. His primary mission was to tow huge windsocks shaped like the fuselage of an airplane as gunnery practice for Spitfires. In 1950, after he refused to join the Communist party, he "got in a few arguments with the Russians," escaped to West Berlin and then to America, became a U.S. citizen, and joined the army.

Once discharged in the early 1950s, Tichacek flew for air cargo services before founding Milo's Aerial Advertising in 1973. Initially he towed commercial banners announcing new products and promotions.

But his recent success as a matchmaker is not only becoming legendary, it's creating business for his competition. Last September Tichacek was hired to tow "Mary Will You Marry Me? I ♥ You" around the University of Santa Clara stadium during a football game. Somehow Mary's father got word beforehand and had a few sentiments of his own to express. No sooner had Tichacek's Stearman made its first circuit when another banner, towed by a Bellanca Scout, appeared over the bleachers. "Mary Think It Through," it read. "Love, Dad."

—Elaine de Man

Update

The re-creation of the Vin Fiz transcontinental flight (In the Museum, August/September 1986) was successfully completed on November 12, 1986, by IBM

engineer James Lloyd, who flew an ultra-light aircraft modified to resemble the original. Lloyd, 38, made 101 stops during the 57-day flight, which exceeded the 1911 flight by eight days and required an additional 25 stops. He returned home from Long Beach, California, by train, because "getting in a 747 just wouldn't seem right."

The Polar BEAR satellite reclaimed from the National Air and Space Museum by the Air Force (In the Museum, October/November 1986) was launched from Vandenberg Air Force Base on a Scout rocket on November 13, 1986. From its polar orbit, the 275-pound satellite will photograph the Northern Lights and study electrical particles and the Earth's magnetic field in a program to improve communications over polar regions.

China's F-8 II fighter, displayed as a model at Farnborough (Soundings, December 1986/January 1987), has sparked a major courtship effort by U.S. aerospace giants. The object of their affections is a planned $550 million purchase of 55 avionics packages for the twin-engine, single-seat airplane. Westinghouse Defense Corporation and Emerson Electric Company made last-minute decisions to participate in the Asiandex '86 defense equipment exposition in Peking in hopes of winning a contract.

Arianespace plans to resume flights shortly ("Ariane," June/July 1986) with a redesigned and more powerful third-stage igniter on its launch vehicles. Three third-stage failures had occurred, the last on May 30, 1986. Ariane has scheduled seven launches carrying eight or nine payloads for this year. The U. S. Air Force had considered using Ariane to launch a backlog of several global positioning satellites, but decided to buy American.

Studies of high-energy solar processes begun by NASA's Solar Maximum mission ("Here's Looking at You, Sol," October/November 1986) will be continued by SOLAR-A, a Japanese-U.S. spacecraft to be launched into low Earth orbit from the Kagoshima Space Center in the autumn of 1991. Gamma- and X-ray observations will continue for the planned three-year duration of the scientific mission.

Plans to recycle external tanks from the shuttle (Soundings, October/November 1986) are being pursued by External Tanks Corporation, which recently announced its Space Phoenix program to convert expended fuel tanks into low-Earth-orbit research facilities. ETC chairman Tom Rogers estimates that such facilities could extend space-based research capacity 20 times beyond that of the space station proposed for the 1990s.

Japan's H-1 and H-2 rockets (Soundings, August/September 1986) will not be marketed for commercial launches, says Washington, D.C.-based NASDA representative Tsuguo Tatakawe. Citing current plans to fulfill domestic needs first, Tatakawe says that Japan can launch only two rockets a year, and at rates not competitive with those of China or Arianespace. Also, launches are restricted to four months each year, a limit established by island fishermen, whose nets are ripped by falling solid-fuel boosters.

—Patricia Trenner

Healthy Skies

Susan Davis

In this new age of health consciousness, it is fitting that the National Academy of Sciences has established a panel to root out hazards aboard airliners. Several health magazines have also jumped on the bandwagon. I applaud these developments. As a recent convert to the joys of well-being, I think it is a duty to spread the gospel of physical fitness on land, on sea, and even in the air.

The newfound dangers at 30,000 feet include recirculated air in the cabin, which is contaminated with cigarette smoke, viruses, and cosmic radiation, and is as dry as a well-made martini because of the air conditioning. Cabin pressurization can cause edemas—swelling, to you and me—which is why you sometimes can't get your shoes back on after a long flight. Add tight-fitting clothing, coffee, soda, and alcohol, and you'll be lucky to get your jacket back on.

Seats, which we passengers have always found uncomfortable, often cause backaches and can block the flow of blood from the legs to the heart. The standard cuisine consists mainly of fatty foods, apparently because they are easy to prepare, keep well, and make diners feel fuller. And finally there is motion sickness, which . . . well, you know about that.

Fortunately, I have developed a program for avoiding most of these menaces, though I haven't yet conquered cosmic radiation. I first effected my plan under field conditions on a recent flight.

Before departing for the airport, I called the airline and ordered a special meal of goat cheese, bark, asparagus, and whole wheat toast (unbuttered). The nutritionist, after snorting something I didn't catch, assured me that my order would be filled.

I then slipped on a cotton shirt, a pair of baggy cotton pants, and some wicker slippers, all purchased especially for the flight. The pants were beltless and a size larger than normal, a precaution against the onslaught of edemas. Besides being dressed for maximum comfort, I had the advantage of looking like I just stepped off the set of "Miami Vice."

At the airport, I skipped my former heedless ritual of a bloody mary, ducking instead into the men's room to strip and anoint myself with baby oil. I also checked my carry-on gear to be sure I had lip balm, hand cream, and eyewash. Braced against edemas and dehydration, I marched to the gate, clutching the waist of my trousers.

On board, I was peeved to discover that, despite my wishes, the airline had assigned me a window seat instead of one on the aisle. Being closer to the longitudinal center of the airplane provides a significant hedge against motion sickness, I firmly explained to a flight attendant. Awarded my original choice, I felt a twinge of sympathy for the fellow who scooted over to the window seat.

Once airborne, I launched into a series of exercises. First, I put my seat all the way back and began to breathe deeply and regularly. But the passenger behind me kept striking the seat-back with his knees, no doubt inadvertently, ruining my meditative concentration. I went on to exercise two.

Hands on knees, I bent forward, rolled my shoulders from side to side, and shrugged. Tension flowed from my body. Next, arms overhead, I grasped my elbows and tilted several times from side to side.

The man in the window seat began to stare, but I was prepared for such a reaction. "A healthy body leads to a healthy mind," I informed him, eyeing his Harold Robbins novel. Mumbling under his breath (which no doubt wasn't deep enough), he shifted his gaze out the window.

Carrying on, I tapped my feet, first the toes, then the heels, toes, heels. . . . I crossed my right ankle over my left knee and began drawing the letters of the alphabet in the air with my toe. As I executed a capital G, my foot was crashed into by an elderly woman. The fellow by the window muttered again while an attendant helped the lady to her feet and bore her aft.

I continued the prescribed regimen, alternately lifting my knees to my chest and bending down to my knees, all on the count of eight. Feeling unusually fit as the drink cart arrived, I ordered an apple juice—they were out of carrot—rather than the usual cocktail (double). People around me soon took to talking and laughing—a nervous reaction, I supposed, to dehydration and poor circulation. I buried my nose in the latest issue of *Whole Life* so as not to make them feel even worse.

Lunch arrived. I ate my cheeses, bark, and asparagus, and once the tray was removed I began another round of exercises. But then I was caught in the queasy grip of what could only have been a bug picked up days earlier from some unconverted stranger. Grateful that I had been assertive about an aisle seat, I made it easily to the lavatory without embarrassing myself.

Our flight was soon over and I disembarked, not only having overcome the hazards of flight but possessed of a brilliant idea, which I have since shared with the Federal Aviation Administration. I suggested that airlines be required to set aside space in each airplane, perhaps in the rear near the galley, for an exercycle and a sauna, along with a day-care center so parents with infants can exercise as well.

I expect to see this idea implemented soon. After all, what airline would balk at building a healthier America?

—Jake Page

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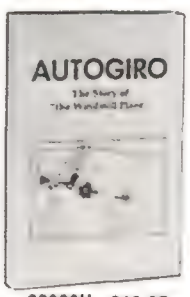

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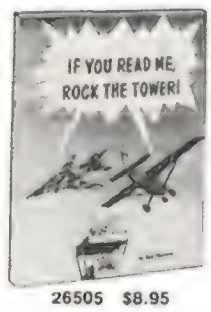

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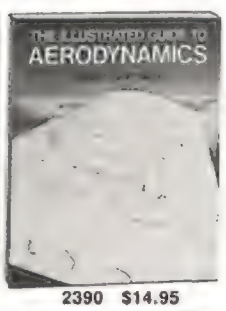

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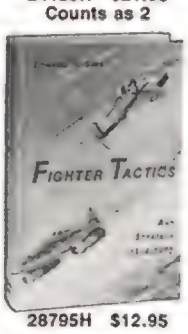

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Anniversaries . . .

1781
March 13 The English astronomer Sir William Herschel discovers the seventh planet from the sun, Uranus, named for the mythological sky god. Herschel later discovered Uranian and Saturnian satellites; his sister Caroline discovered eight comets and three nebulae; and his son Sir John cataloged thousands of double stars, clusters, and nebulae in a volume still used today.

1879
March 14 Albert Einstein is born in Ulm, Germany. When Einstein was 15, he helped his uncle Jakob through some calculations for the construction of a new machine. Jakob Einstein later told a friend, "You know, it is really fabulous with my nephew. After I and my assistant engineer had been racking our brains for days, that young sprig had got the whole thing in scarcely 15 minutes. You will hear of him yet."

1913
March 2 Flying pay is authorized for the U.S. Army: 35 percent over base rate for a maximum of 30 officers who were "actual fliers of heavier-than-air craft." The Air Force currently employs a sliding-scale "aviation career incentive pay" system that ranges from $125 to $400 per month over base pay, depending on years of service. The amount increases through the sixth year of service, then declines.

NASM

Robert Goddard's 1926 liquid-fuel rocket launched today's space explorations.

1926
March 16 At his aunt Effie's farm in Auburn, Massachusetts, Robert Hutchings Goddard launches the first successful liquid-fuel rocket, which flies 184 feet in two and a half seconds. He spent the rest of his life perfecting the overall design, funded primarily by the Smithsonian. In 1927 he built a particularly ambitious rocket that could not lift its own weight. "Instead of a little flier," wrote his wife Esther, who was charged with extinguishing fires caused by rocket exhaust, "he had built a big sitter." Goddard's successes, however, were the key to space flight. In the words of one scientist, "Every liquid-fuel rocket that flies is a Goddard rocket."

1927
March 27 The Orteig Prize committee accepts an entry from a Charles Augustus Lindbergh, one of a handful of pilots competing for the $25,000 prize offered in 1919 to the first flier to cross the Atlantic nonstop from France to New York or vice versa (see page 86).

1930
February 18 Clyde William Tombaugh discovers the planet Pluto. Tombaugh was continuing studies of photographic plates begun in 1905 by Percival Lowell, who predicted the location of "Planet X" through calculations based on the perturbed orbits of Neptune and Uranus. The announcement of the discovery was made on March 13, the 75th anniversary of Lowell's birth. Recent measurements of the planet, made as it eclipsed its moon, Charon, indicate that it is 30 percent smaller than originally thought, supporting the theory that Pluto, with its decidedly unplanetlike orbit, is actually an escaped moon of Neptune.

A Guernsey named Elm Farm Ollie becomes the first cow to fly. A publicity stunt flight took Ollie and a corps of reporters over St. Louis, Missouri. Ollie was milked during the flight, and the milk was parachuted to the ground in sealed paper cartons.

1935
March 17 A passenger is discovered smoking in the cabin of a Handley-Page Heracles during an Imperial Airways Paris-to-London flight and is fined £10 by the Croyden Police Court.

1939
February 14 The U.S. Army Air Force's Boeing XB-15 bomber prototype flies its only mission: a 30-hour nonstop flight carrying 3,250 pounds of medical supplies to earthquake victims in Chile.

1949
February 26–March 2 A U.S. Air Force Boeing B-50 Superfortress makes the first nonstop round-the-world flight. The *Lucky Lady II* refueled four times during the 94-hour, 23,452-mile round trip flight from Forth Worth, Texas.

NASM

George Smith made aeromedical history when he survived a supersonic bailout.

1955
February 26 George Franklin Smith, a North American Aviation test pilot, becomes the first person to survive a low-altitude bailout at supersonic speed. Smith ejected from an F-100A Super Sabre at 777

mph 6,500 feet over Los Angeles after the controls froze at 35,000 feet. Air Force doctors estimated that Smith suffered a deceleration force of 40 Gs. His socks, helmet, oxygen mask, watch, and ring were torn off, his clothes cut to ribbons, and his parachute torn. He was rescued in the ocean off Laguna Beach by a passing boat and hospitalized for seven months. A month later he resumed flying—in slow, lightweight aircraft.

1958
March 17 The U.S. Navy launches Vanguard 1, the first solar-powered satellite. Vanguard proved that the Earth is actually pear-shaped rather than spherical, due to a bulge caused by stress deep within the planet. The satellite transmitted data for seven years, and today is the oldest manmade object in Earth orbit.

1962
February 20 The Mercury *Friendship 7* capsule carries Marine Corps lieutenant colonel John Herschel Glenn Jr. into three Earth orbits in five hours. Glenn was the first U.S. astronaut and the third man to orbit the planet, preceded by Soviets Yuri Gagarin and Gherman Titov.

1963
February 14 NASA makes the first attempt to place a satellite into geosynchronous orbit, in which objects orbit the Earth at the same speed the planet rotates and therefore appear motionless in the sky. However, seconds after the kick motor fired to insert Syncom 1 into its final orbit at 22,300 miles, the communications satellite went into an electronic sulk and was never heard from again, though its orbit is still tracked today. The more gregarious and successful Syncom 2 was launched in July.

1965
March 18 Lieutenant Colonel Aleksei Leonov performs the first space walk—EVA (extravehicular activity) in astrospeak. He took his 10-minute stroll while tethered to Voskhod 2.

1970
February 11 The University of Tokyo launches Japan's first satellite, an engineering test device named Ohsumi after the peninsula it was launched from. Japan was the fourth nation to place a satellite in orbit.

1971
March 24 The U.S. Senate votes to drop funding for an American SST, which cancels the Boeing 2707 project.

1979
March 4 & 9 Voyager 1 detects the rings of Jupiter and returns the first images of an active volcano on another celestial body, a moon of Jupiter named Io.

NASM

Voyager 1 finds a volcano on Io.

1984
February 7 Propelled by MMUs, or manned maneuvering units, Bruce McCandless and Robert Stewart backpack through space, up to 300 feet from the shuttle *Challenger.*

. . . and Events

Through February 19
"Early Flight: 1900–1911," Smithsonian Traveling Exhibition. At Adirondack Community College, Glens Falls, NY, (518) 793-4491.

February 1
"Wings Over the Ocean," seminar by E.T. Wooldridge, National Air and Space Museum. At Jacksonville Museum of Arts and Sciences, Jacksonville, FL. Smithsonian National Associates, (202) 357-1350.

"Behind the Scenes at the National Air and Space Museum," lecture by E.T. Wooldridge. At Florida Community College, Kent Campus, Jacksonville, FL. Smithsonian National Associates, (202) 357-1350.

February 2
"Winged Wonders: The Story of the Flying Wing" and "Behind the Scenes at the National Air and Space Museum," seminars by E.T. Wooldridge. At University of Florida, Gainesville, FL. Smithsonian National Associates, (202) 357-1350.

February 4–March 15
"Twenty-five Years of Space Photography," black-and-white and color images from NASA's unmanned missions. At the Exploratorium, San Francisco, CA, (415) 563-7337.

February 7 & 8
Blue Angel Invitational Golf Tournament. Honors the Navy's Air Demonstration Squadron, which practices during the winter months at NAF El Centro. At Barbara Worth Country Club, Holtville, CA. El Centro Chamber of Commerce, (619) 352-3681.

February 7–March 8
"Black Wings: The American Black in

Smithsonian Traveling Exhibition "Black Wings" comes to Hampton, Virginia.

USAF

Aviation," Smithsonian Traveling Exhibition. At NASA Langley Visitors Center, Hampton, VA, (804) 865-2855.

February 17–19
"Air and Space in the Year 2000: The Engineering Challenges," 1987 Aerospace Engineering Conference and Show. Topics include the aerospace plane, space station and shuttle, and aircraft/space systems transition technology. Speakers include top NASA and Air Force personnel and Voyager pilots Dick Rutan and Jeana Yeager. At Los Angeles Airport Hilton, Los Angeles, CA. American Institute of Aeronautics and Astronautics, (212) 408-9740.

February 26–28
Helicopter Association 39th International Convention. At Dallas Convention Center, Dallas, TX. HAI, (703) 683-4646.

March 9–11
"Automation, Robotics, and Advanced Computing for the National Space Program," symposium on autonomous systems for space applications. Sponsored by American Institute of Aeronautics and Astronautics, NASA, and the Air Force. At Crystal Gateway Marriott Hotel, Arlington, VA. AIAA, (212) 408-9748.

March 15–21
Annual Sun 'n' Fun Fly-in. Florida's mini-Oshkosh kicks off the fly-in season with aircraft displays, aerobatic performances, and aviation seminars. At Lakeland Municipal Airport, Lakeland. Experimental Aircraft Association, (813) 644-2431.

March 16–20
18th Annual Lunar and Planetary Science Conference. At Johnson Space Center, Houston, TX. Opening-day symposium with American and Soviet panelists on international cooperation in space exploration. Lunar and Planetary Institute, (713) 486-2150.

March 20
"Behind the Scenes at the National Air and Space Museum," lecture by Claudia Oakes. At Luther Burbank Center, Santa Rosa, CA. Smithsonian National Associates, (202) 357-1350.

Spring begins with the vernal equinox at 10:52 p.m. EST in the Northern Hemisphere, and autumn begins with the autumnal equinox in the Southern Hemisphere. *

March 21
"The Golden Age of Flight," seminar by Claudia Oakes. At Luther Burbank Center, Santa Rosa, CA. Smithsonian National Associates, (202) 357-1350.

March 23–26
Upper Midwest Aviation Symposium. At Kirkwood Motor Inn, Bismarck, ND. North Dakota Aviation Council, (701) 774-8594.

March 26–28
National Congress on Aviation and Space Education. The 20th forum for educators to promote aerospace education. At Sheraton Twin Towers, Orlando, FL. Civil Air Patrol, (205) 293-5371.

March 27
"Behind the Scenes at the National Air and Space Museum," lecture by E. T. Wooldridge. At Museum of Science and Industry, Los Angeles, CA. Smithsonian National Associates, (202) 357-1350.

March 27–29
"Return to the Vision." Sixth annual L-5 Society space development conference. At Pittsburgh Hilton, Pittsburgh, PA. L-5 Society, (412) 351-4973.

March 28
"Winged Wonders: The Story of the Flying Wings," seminar by E. T. Wooldridge. At Museum of Science and Industry, Los Angeles, CA. Smithsonian National Associates, (202) 357-1350.

March 28–April 26
"Jupiter and Its Moons," Smithsonian Traveling Exhibition. At Sandor Teszler Library Gallery, Wofford College, Spartanburg, SC, (803) 585-4821.

March 29
Annular-total solar eclipse. Visible from Africa, the Atlantic Ocean, and southern South America. *

March 29
"Wings Over the Ocean," lecture by E. T. Wooldridge. At Museum of Science and Industry, Los Angeles, CA. Smithsonian National Associates, (202) 357-1350.

** Call the Smithsonian Earth and Space Report for recorded information on astronomical events at (202) 357-2000.*

Organizations wishing to have events published in Calendar should submit them at least three months in advance to Calendar, Air & Space/Smithsonian, *Room 3400, National Air and Space Museum, Washington, DC 20560. Events will be listed as space allows.*

—Patricia Trenner

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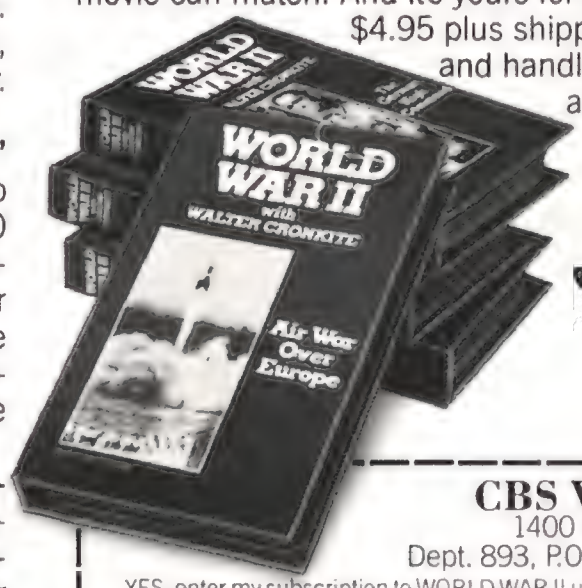

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Mark Avino/NASM

In 1986 Ray Brooks stands seven decades away from...

In a book titled *New England Aviators, 1914–1918* there is a photograph of Arthur Raymond Brooks. He was a young man then, all of 22 years old, a graduate of the Massachusetts Institute of Technology who enlisted as an aviator to fight the good fight against the Hun in Europe. In the portrait he wears his uniform, with aviator wings on his chest and the beginnings of a smile on his lips.

In the National Air and Space Museum's World War I gallery there is a SPAD XIII biplane, a spruce-and-fabric beauty with a small scalloped tail. Painted on the narrow fuselage is a shooting-star insignia, below that a series of white gravestones with black German crosses. The airplane, named *Smith IV*, has been meticulously restored at the Museum's Garber Facility, and looking at it you feel as though time had been turned back to when Ray Brooks was the fresh-faced young man in the photograph. In fact, Brooks flew this airplane; came close to death, survived, and shot down the enemy in it. "You must understand," Brooks says now, nearly seven decades after he arrived in France in March 1918, "I never expected to live beyond the age of 22."

But he did, managing to score six official victories over enemy airplanes—one more than needed to be named an ace. Among the airplanes he fought were those belonging to the Flying Circus of the Red Baron, Manfred von Richthofen. During one such encounter in a SPAD VII, Brooks downed two members of the circus in a wild free-for-all, then managed to coax his airplane to the ground, its rudder controls shot away, to find that it had been hit by 120 bullets.

When war broke out in Europe, one of the companies that set to work designing warplanes was the Société pour les Appareils Deperdussin, or SPAD. The company had been founded by a silk manufacturer named Armand Deperdussin, but when he was jailed in 1914 for misusing company funds aviator Louis Blériot took over. He changed the company's name to the Société pour Aviation et ses Dérives, keeping the acronym. He also kept the company's designer, Louis Bechereau.

Brooks' first SPAD was a VII, which he named *Smith* in indirect honor of his fiancée. "Her name was Ruth," Brooks explains, "and Ruth was in Smith College. I didn't like the idea of having the plane come down with a busted tail skid or something and saying, 'Ruth's tail is busted.' That wouldn't have worked out."

The young aviator was not completely pleased with the SPAD VII, which he dubbed a "flying brick" because of its notorious gliding characteristics. Nor was he fond of the untrustworthy armament. "I didn't particularly like the SPAD type VII, which had one—unfortunately—lousy Vickers gun," Brooks says. "When I say that, it is advisedly so, because we worked on them and they still jammed. When you had only one Vickers gun that was undependable, you did what you could by praying a little." But, he concedes, "I still was satisfied in the main."

Eventually the SPAD VII was replaced by the more powerful XIII model, with its two Vickers machine guns. "When we got the SPAD XIII, with two similar not-too-good Vickers guns, it was still a better risk and a better chance," says Brooks. "We would take those deliveries, and I would put on overalls and work on them with my crew. We wanted to be able to fight in something that when you poured on the coal would work, and when you maneuvered wouldn't fall apart." His modifications would later include replacing the unpopular Vickers guns with more reliable weapons.

The *Smith*s, *I* through *IV*, didn't let Brooks down, although *Smith IV* was so bullet-ridden after one battle that the upper wing had to be replaced. But it took a liberty bond drive, not the Germans, to separate Brooks from his airplane. After the Armistice, two airplanes from Brooks' squadron, the 22nd Pursuit, were requisitioned to aid in a treasury department bond drive back in the States. "I didn't want to send them back," Brooks says, "because we were going to go up to Germany for occupation duty and I didn't want to lose two good airplanes. I resisted and was told in no uncertain terms, 'You've got your orders.' So I did send them and they did their job." One of the two airplanes sent was Number 20, *Smith IV*.

Brooks remained in the service and became the commanding officer of the 22nd Pursuit. He followed his airplane to the United States in July 1919, a captain and a recipient of the Distinguished Service Cross. *Smith IV*, in the meantime, had been given to the Smithsonian by the treasury department.

"At the time—I think I was at Langley Field—somebody said, 'Hey, your plane's in the Smithsonian,' and I didn't believe him!

"I went over," Brooks relates, "and was upset emotionally, and with some trepidation I automatically climbed into the cockpit. And a guard came over and gave me what for! And I said, 'I'm sorry, but this was my airplane.' 'Fine,' he said, '*you* stay there, *you* answer the questions!' Well, I did stay there, and was looking at the controls, moving the rudder, and lo and behold, up comes Paul Garber because the guard, without my knowing it, had gone to the telephone and told Paul Garber that Ray Brooks had shown up."

NASM

. . . the young man (center) who flew Smith IV *in World War I.*

At the time Garber constituted the entire aviation staff at the Smithsonian, and he convinced Brooks to write up a short history of *Smith IV* for display with the airplane. It was the beginning of a friendship that endures today.

In 1922 Brooks, angered over a government act that would automatically downgrade his rank, decided to resign from the service. For a time he worked with fellow ace Reed Chambers, who was attempting to start Florida Airways with Eddie Rickenbacker. In 1928, following service with the commerce department's aeronautics agency, Brooks joined the Bell Telephone Company, where he tested air navigation equipment. However, several operations for back problems in the early 1940s prevented him from flying in the war following the War to End All Wars.

It's been nearly seven decades since young Ray Brooks had his portrait taken. Today, at 91, he patiently retells the story of *Smith IV* to historians, the media, and children, recreating history from a wealth of memories. At a Museum reception last November to honor his achievements and mark his restored airplane's placement in the World War I gallery, Ray Brooks had a chance to meet up with a number of people from his past and reflect a bit on his life. "I had a great life full of charm," he said, sitting near *Smith IV*, "and it is still a charming life. . . . I am very emotional and very supremely happy."

Filmed History

Scores of aviators and long-forgotten aircraft wait in underground bunkers. Charles Lindbergh is there; so, too, are Amelia Earhart, Glenn Curtiss, and Roscoe Turner. Time is running out for these aviators; unless something is done soon, they may turn to goo and gum and dust.

Of course the fliers themselves aren't resting in these World War II ammunition bunkers in Fort Jackson, South Carolina. But their images are, captured on hundreds of thousands of feet of Fox-Movietone newsreel footage shot between 1919 and 1933. The film is on nitrate stock, which is flammable and prone to decay, and most of it has never been duplicated. In conjunction with the University of South Carolina, which now owns the film, the Museum is seeking funds to preserve 800,000 feet of aviation-related footage.

Movie audiences today are unfamiliar with the newsreel, but in decades past it was as much a part of moviegoing as buttered popcorn. The largest producer of newsreels was Fox-Movietone News, which started out as Fox News in 1919. At its peak the company had over 1,000 cameramen around the world capturing the day's events on film.

Some footage became part of the 5,000 newsreels produced by Movietone before it ceased production in 1963. But with a production rate of only two newsreels a week, 90 percent of the film shot ended up as outtakes. In 1980 Twentieth Century-Fox, which owns Movietone, announced that it would donate some 60 million feet of newsreel footage to the University of South Carolina. Included with the collection are thousands of index cards detailing what's on the film, as well as the cameramen's "dope sheets," scene-by-scene breakdowns of what they had shot.

The aviation footage, nearly 150 hours' worth from flight's golden age, includes film from Movietone's first sound newsreel, which covered Charles Lindbergh's takeoff for Paris in the *Spirit of St. Louis*. Other outtakes include a conversation with Amelia Earhart before she embarked on her failed round-the-world flight, Glenn Curtiss retracing his first long-distance flight, and Roscoe Turner and his pet lion, Gilmore, stopping in Kansas during a record-breaking cross-country trip.

The Museum became involved when Patricia Woodside, film producer for the Museum's Exhibits Department, was seeking shots of Grumman F6F Hellcats and Japanese Zeros for the Hellcat exhibit. When a retired Movietone cameraman told her about the gift to the university, Woodside realized the role the Museum could play. Often the cameramen would identify the people in the footage and what they were doing, "but they often didn't identify the aircraft," Woodside says. "Museum curators could do that."

Unfortunately, time will take its toll on the delicate film, so the Museum and the university are looking for a corporate sponsor to fund the necessary preservation work. The proposed funding, estimated at $550,000, would enable technicians to transfer the aviation footage from nitrate stock to damage-resistant film. The money would also finance a video library of the film, which would be available to the public.

To date, the Museum has received a $15,000 donation from the Smithson Society but is still looking for a corporate sponsor. Until one is found, footage of the

University of South Carolina

The decay of some Movietone newsreel film is apparent.

Graf Zeppelin passing through the Golden Gate, the opening ceremonies for the 1929 Cleveland Air Race (with Gloria Swanson firing the opening cannon), the *Spirit of St. Louis* arriving at the Smithsonian, and even the first bull to fly will have to hold out against the relentless march of time in the dark ammunition bunkers.

—*Tom Huntington*

The Ultimate Getaway

While a crew of five astronauts and two civilians studied crystal growth, blood storage, and comet imaging aboard the orbiter *Columbia* in January 1986, an unassuming barrel in the cargo bay was working on projects of its own. Called Julie, the National Aeronautics and Space Administration's Get Away Special container carried 20 medical experiments developed by St. Mary's Hospital in Milwaukee, Wisconsin. Julie was named after the hospital's president, Sister Julie Hanser, but the name also stands for Joint Utilization of Laser Integrated Experiments because the canister's tests evaluated the effects of laser light, cosmic radiation, and weightlessness on drugs and filters.

Last fall a delegation from St. Mary's donated the Julie payload to the Museum. Because the results are still being studied and a private company wants to lease some of the hardware for its own tests on a future shuttle mission, the experiment equipment wasn't included. The hospital plans to donate some of the test equipment once studies are completed, says Myron Muckerheide, director of the hospital's laser research laboratory. It was Muckerheide who first thought of conducting these experiments in space and then began recruiting a small army of experts to develop the project. Contributors included such big names as

Hughes Aircraft and Procter & Gamble.

Why do medical research in space? "There's no laboratory on Earth that can simulate the days of microgravity that the shuttle affords," says Muckerheide, adding proudly, "We're the first hospital that ever flew in the GAS program." The program, which offers low-cost launches for small, self-contained experiments, is a popular one: NASA has launched 53 canisters on 13 shuttle missions, and has 400 reservations. Project Julie shared its berth with a dozen other canisters, which look like oil drums with colorful program decals.

Project Julie will eventually become part of a Museum exhibit called "America's Space Truck—The Space Shuttle," which will feature a section on the GAS program, says Derek Elliott of the Museum's Space Science and Exploration Department.

—Linda Billings

Patch and Julie logged three million miles.

Museum Calendar

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202) 357-2700 for details.

Tuesday Nights "Star Heroes" Film Series. Feature films in Langley Theater, 7:30 p.m. February 6: *Buck Rogers: Destination Saturn* (free). February 13: *Planet of the Apes* (free). February 20: *Space Camp* (admission $1). February 27: *Return of the Jedi* (admission $1).

February 7 Monthly Sky Lecture: "Sky Shooting." Geoffrey Chester, Planetarium Production Coordinator, NASM. Albert Einstein Planetarium, 9:30 a.m.

February 7 & 21 Presentation: "Air and Space Restoration at the Paul E. Garber Facility." 10:30–12 noon and 1–2:30 p.m. Call Resident Associates Program at (202) 357-3030 for ticket information.

February 17 Starlight Serenade Concert Series: U.S. Air Force Chamber Players. Albert Einstein Planetarium, 8 p.m.

February 18 Exploring Space Lecture: "The Earliest History of the Universe." Michael S. Turner, Fermi National Accelerator Laboratory. Albert Einstein Planetarium, 7:30 p.m.

February 19 General Electric Aviation Lecture: Alvin S. White, XB-70 test pilot. Langley Theater, 7–9:30 p.m.

February 21 Seminar: "Is There Life in Outer Space?" Carmichael Auditorium, 10 a.m.–5:30 p.m. Call Resident Associates Program at (202) 357-3030 for ticket information.

February 25 Lecture: "Senator John Glenn Commemorates the 25th Anniversary of the Flight of *Friendship 7.*" Langley Theater, 8 p.m. Call Resident Associates Program at (202) 357-3030 for ticket information.

March 7 Monthly Sky Lecture: "The Search for Planet X." Ellen Sprouls, Planetarium Specialist, NASM. Albert Einstein Planetarium, 9:30 a.m.

March 17 Starlight Serenade Concert Series: U.S. Air Force Chamber Players. Albert Einstein Planetarium, 8 p.m.

March 18 Exploring Space Lecture: "Quasars and Active Galaxies." Bruce Margon, Astronomy Department, University of Washington. Albert Einstein Planetarium, 7:30 p.m.

March 19 General Electric Aviation Lecture Series: Royal Air Force Air Vice Marshal Ron Dick. Langley Theater, 7–9:30 p.m.

Come visit the Museum on a "Washington Anytime" weekend—two nights (double occupancy) for $99. Includes accommodations, some meals, Museum tour, IMAX film. For details call or write to the Associates Travel Program, Capital Gallery 455, Smithsonian Institution, Washington, DC 20560, (202) 287-3362.

On the Wings of the Garuda

by Phil Cohan

Indonesian legend has it that the Hindu god Vishnu soared through the heavens on the back of the garuda, a giant celestial eagle symbolizing creative energy. And evidence of the mythical bird's importance in Indonesia is widely apparent. The garuda is the national symbol, and Indonesians have even adopted its name for the country's flag airline.

While the garuda is an ancient symbol of flight, flight is more than a symbol to modern Indonesia. It is a necessity. Indonesia's national motto is *Bhinneka Tunggal Ika,* "Unity in Diversity," and the diversity of this 3,200-mile-long cluster of islands is extraordinary. Within its borders dwells the world's fifth largest population, at 160 million, and its largest Moslem population. But Christianity, Hinduism, and Buddhism have also strongly influenced the nation's history and culture. All told, Indonesia includes more than 250 ethnic groups, with an equal number of distinct languages and dialects. And to an increasing degree, the force that binds all this diversity is flight.

The 13,677 islands that make up the archipelago stretch from Australia almost to Vietnam. Since the time of Ptolemy, they have been famed for the warm splendor of their beaches and skies. Some of the names have changed in recent years, but the historic association with adventure and enchantment seems likely to endure forever. Java, Bali, Sumatra, the Celebes, Borneo, the Spice Islands—all evoke the sounds and fragrances of another age.

Over the centuries, nations and empires seeking power, influence, or trade have tried to woo or coerce the islands' people. But Indonesia outlasted these attempts, preserving from each relationship only what served it best.

Holland was perhaps the most insistent, holding sway for almost 350 years, primarily on Java. First trading in spices and later in the coffee beans they introduced, the Dutch thrived on the commerce they built before the Japanese took over what had become the Dutch East Indies. When Tokyo surrendered its hold after World War II, Indonesia proclaimed its independence. The Dutch tried to regain control, but the Indonesians fought back and finally won recognition of their freedom in 1949.

Indonesia has since made astonishing progress in many sectors, but its economy continues on a roller coaster course. Development of oil fields in Sumatra and its coastal waters, as well as on the seabed off Kalimantan, part of the island of Borneo, has helped fuel the economy—but not to the degree that had once been hoped. A national economy based on oil is a lot like the little girl with the curl in the middle of her forehead. When the oil market is good, it's very, very good. But when it's bad, it's horrid.

Jets troll the air routes of Garuda, Indonesia's flag airline, and return laden with the staple of tourism.

Indonesia turned to aerospace to solve its transportation dilemma, and in the bargain found a technology to fuel its future.

Photographs by Christopher Springmann

The garuda's splendor evokes its role as creativity's source. This eight-foot version graces an aircraft factory.

Even the towers of Java's colossal 1,100-year-old Buddhist temple of Borobudur seem to urge Indonesians to look skyward.

Lee Battaglia

In Jakarta's teeming open-air markets, business is conducted following centuries-old traditions that manage to coexist with modernization.

Lee Battaglia

Seeking other sources of revenue, the nation has turned to tourism, and Garuda Indonesia airline is the pipeline that brings in tourist dollars. Bali, with its rich Hindu heritage, has become the focus of an aggressive tourism industry, and Ngurah Rai International Airport at Denpasar, the island's capital, has grown to be Garuda's major terminus. The island draws 60 percent of all visitors to Indonesia, which is hardly surprising since it is blessed with all the requisite attractions: radiant skies, perfect beaches, clear water, exquisite tropical flora, a backdrop of craggy mountains, and a friendly, handsome populace. Visitors are steeped in centuries of tradition: intricate carvings, mysterious shadow puppets, haunting gamelan music, and, perhaps the one Bali treasure that leaves the most lasting im-

pression, the superb grace of its masked ritual dance.

Bali has long exerted an exotic charm. When the first Dutch vessel arrived in the late 16th century, every man-jack aboard jumped ship. It took the captain two years to round up his dazzled crew, and he set sail at once to escape the siren call of the island paradise. Today's tourists aren't much different. And to capitalize on this allure the government hopes to attract a million visitors a year, trebling the current rate, beginning in 1988.

The island of Java has always been Indonesia's political center. It's therefore fitting that Java's new airport, Sukarno-Hatta International, serving the national capital at Jakarta, is named for the first president and vice president. While Jakarta attracts tourists with its

Julie Schieber

The Indonesian archipelago sits astride the trade routes connecting Asia to Australia and the Indian Ocean to the Pacific.

sophistication, many head for Jogjakarta, the centuries-old center of traditional Javanese culture and the site of the sultan's palace. Also nearby is the glorious 1,100-year-old Buddhist temple of Borobudur.

An inter-island air transportation network reduces what once had been weeks-long boat voyages to trips measured in mere minutes. Besides Garuda, with its fleet of 74 airplanes, four domestic carriers provide service. Aircraft of the government-owned Merpati Nusantara and the privately owned Bouraq airlines are a common sight at both urban Jakarta and provincial airports. Two small private companies, Sempati and Mandalah, operate a handful of smaller airplanes.

But within the last decade Indonesia has looked beyond the obvious benefits of building an efficient transportation system to something far more ambitious. The nation has set out to become nothing less than a major presence in the world's aerospace industry, and the garuda's symbolizing of creative energy has taken on an altogether new and more important dimension. No Indonesian better personifies the notion of creative energy than Bacharuddin Jusuf Habibie.

Habibie is president of Industri Pesawat Terbang Nusantara (IPTN),

A growing air fleet serves the petroleum industry and its many offshore platforms. Indonesia's largest revenue source is oil (above).

Pilots Ester Saleh and T. R. Suryosumarno crew a national aircraft factory transport (below).

Life raft imitates art as airline cabin attendants practice evacuation drills at Garuda's training center.

the state-owned aircraft company that was until recently known as Nurtanio, as well as the nation's minister of research and technology. Together with R.A.J. Lumenta, national director of Garuda Indonesia, he has fashioned a vision in which international prominence and power in the skies form a key part of the answer to his nation's needs.

Indonesia is a land where mysticism and modernity coexist in fascinating, sometimes perplexing ways. It's the sort of place where people feel comfortable running spreadsheet programs on a personal computer in the morning and visiting a shaman in the afternoon to plan tomorrow. All Indonesians live under terrific pressure to accommodate tradition and observe the old ways. But the same people have managed to produce advanced airplanes and helicopters under Habibie's canny management.

After training in West Germany as an aeronautical engineer, Habibie rose to become a vice president at Messerschmitt-Bölkow-Blöhm, a leading West German aerospace firm. Indonesian president Soeharto summoned him home in the mid-1970s to head the nation's aerospace efforts. Habibie has preached tirelessly about the benefits a developing country could derive from a well-formed science and technology program, and today it's clear that his message got through.

Indonesia now boasts several modern complexes for aircraft design, manufacture, and testing. And IPTN has a workforce of roughly 13,000 people, which Habibie predicts will increase to 60,000 within 20 years. Whenever he talks with foreign investors, Habibie stresses that labor costs in Indonesia are 60 percent lower than those in the United States and Japan.

It would be easy—but wrong—to think of B. J. Habibie as a man from the future, a sort of Connecticut Yankee plunked down in a nation bound by its

This CN 235 airliner is more than sunshade for these Indonesians; it's part of their future.

Last June's government-sponsored air show drew world industry along with proud Indonesians (above).

B. J. Habibie, just behind his pilot, gets around in one of the helicopters he has been instrumental in building (right).


PK-XNC
IPTN
DILARANG
MEROKOK

Fifty thousand Indonesian Moslems, like these worshippers in the Al-Azhar mosque in Jakarta, fly Garuda during the annual pilgrimage to Mecca.

Chriss Poulsen

Air and water form the highways for a nation of islands. Residents of a Kalimantan village prefer their houses on stilts, rather than dry land.

past. Instead, Habibie is a man with deep roots in his people's history, but with a keen sense of the modern world and what's necessary for success.

A visit with Habibie confirms the importance of tradition in his country. Soon after you enter his office, coffee is served. And it sits there, cooling, during the conversation. He finally takes a sip—a cue that you may drink, too. But it also signals that the meeting is winding down. The wise guest takes a few more sips while concluding the visit as gracefully as possible. It's the way things are done.

For just over 10 years IPTN has manufactured the CN-212, a utility twin-turboprop transport that can carry 26 passengers or 6,000 pounds of cargo. The company also produces a 44-seat turboprop airliner, the CN-235, that was certified by the U.S. Federal Aviation Administration last October and has begun to enter service with regional U.S. airlines on commuter routes that feed airline hubs. Both aircraft are produced in cooperation with Spain's national aircraft manufacturer, CASA. Under similar agreements with factories in the United States, France, and Germany, IPTN produces its own versions of several types of helicopters.

Habibie is a strong believer in what can be accomplished by a combination of sheer national will and international cooperation. "We want to be self-sufficient," he says. "And we want to become a real partner with other nations' companies so that we can share costs, share risks, share profits, and share work." Habibie speaks openly of his hope that IPTN will become a subcontractor to Boeing for future projects, and he has already signed up to join Boeing and MBB, his former employer, in the design and manufacture of a 110-passenger prop-fan, the NTTC-285. This transonic airliner, powered by a new generation of engines and advanced propellers that employ multiple swept blades, is slated to enter the market in the 1990s.

Indonesia is also moving rapidly into the space age. Last year marked the 10th birthday of its first communication satellite, Palapa A01, which was launched to link the nation with its neighbors in Southeast Asia. Palapa B2, one of a related series of satellites, gained notoriety in 1984 by failing to attain orbit when its booster motor misfired following deployment from the space shuttle. The satellite was later recovered by shuttle astronauts in a highly publicized space rescue, in the hope that it can be refurbished, resold, and someday relaunched.

When Ronald Reagan met with Indonesian president Soeharto in Bali in May 1986, they discussed plans for the launch of the new Palapa B-2P communication satellite (no relation to the recovered B2). It had been scheduled for shuttle deployment but is now set for a launch aboard an unmanned Delta

Government facilities like this acoustics laboratory provide high-tech support for a burgeoning aerospace industry.

The Garuda fleet of aircraft relies on the Jakarta maintenance center whenever repair and refurbishment are needed (left).

The first aircraft built by Indonesia, the NC 212 Aviocar symbolizes an enduring link with its designer, the Spanish firm CASA (right).

rocket this March. The heads of state also reviewed a National Aeronautics and Space Administration program in which two Indonesians trained to become astronauts. To Soeharto's countrymen, the sophisticated nature of the items on the meeting's agenda signified a bigger role for Indonesia on the contemporary world stage.

Last year saw another milestone in the nation's aerospace development, the first Indonesia Air Show, held in Jakarta. "The air show was a celebration," Habibie says. "We have done in the past 10 years what we set out to do. We have raised ourselves to full membership in the world's high-tech aerospace industry." Some 235 companies from 22 nations participated in IAS 86, and the event will be held again in another 10 years.

Although the air show included a variety of advanced combat airplanes, Indonesia's own appetite is largely for transport aircraft. For example, the government-owned oil company, Pertamina, operates the largest air fleet in the country, including 75 airplanes and more than 100 helicopters. Called Pelita Air Service, the company also absorbs many of the graduates of Indonesia's Civil Aviation Training Center near Jakarta. Thousands of pilots, technicians, and air traffic controllers have learned their trades at the center since it opened in 1984. While many graduates find jobs in the oil industry, most go to work for the nation's air carriers, with Garuda Indonesia being the most prestigious.

These CN 235 turboprops will probably fly for domestic airlines, but the country is poised to seek a greater share of the world market.

Garuda is the largest airline in the Southern Hemisphere, employing 700 pilots and operating a modern fleet of jets. Recently, the 30-year-old airline has begun to expand its international routes, including new weekly service to Los Angeles. Garuda also provides 10 flights a week to Tokyo and has signed agreements with a number of international carriers establishing joint operations serving various Asian and European cities. Passenger traffic has been registering double-digit growth, with the strongest increase on the routes to the Middle East.

In the midst of tradition, things are changing, often rapidly. You still get the customary rice roll—sweet, sticky rice wrapped in banana leaves—on a Garuda flight. It's especially tasty when washed down with a small cup of juice. But you won't encounter any more clove cigarettes. The smoking of ***kretek*** was banned, not because of the cigarettes' peculiar scent but because of their tendency to explode into a cascade of sparks when lighted.

And the airline is even getting a new garuda—a logo with bright blue feathers that is being stenciled onto every airplane in the fleet. Indonesians are hardly likely to change things just for the sake of change, though, so the growth of the national aerospace industry is likely to move at a rate that allows tradition to keep pace. But there is little doubt that throughout this newly inspired nation, the creative energy of flight symbolized by the garuda has forged a strong sense of purpose.

An Apollo astronaut has found a new and fulfilling mission on Earth . . .

"To Make the Moon More Beautiful"

by Patricia Trenner

"Monet took a pond of dirty water and green circles and made a beautiful painting of water lilies. I realized it wasn't nature's job to do the same thing with the moon—it was mine."

Six years after switching from astronaut to artist, Alan Bean has sold more than 50 paintings to art collectors and space enthusiasts.

Photographs by David Nance

After walking on the moon, what do you do with the rest of your life? Neil Armstrong joined industry as president of Computing Technologies for Aviation. Academia welcomed Buzz Aldrin as a consultant to the University of North Dakota's space science department. And Alan Bean became an artist devoted to portraying the history of space flight.

Bean, an ebullient Texan with an accent as thick as crude oil, didn't take up painting until he was 30. While flying as a test pilot at Patuxent River Naval Air Station in Maryland, he enrolled in night art classes at Saint Mary's College in 1962. But he had to put his brushes aside the next year when the National Aeronautics and Space Administration selected him to be an astronaut.

In 1969 he was tapped as lunar module pilot on Apollo 12, with Pete Conrad as spacecraft commander and Richard Gordon as command module pilot. There was no time to even think about art during the 10-day mission: "You couldn't daydream too much—you didn't want any new ideas," says Bean, now 55 and living in Houston. "A new thought meant an old one would get pushed aside, and you needed all the facts so you wouldn't forget what to do. I remember looking up at the Earth and thinking, *How beautiful,* but then I had to get back to work."

Space work kept him busy for the next few years. In 1973 Bean served as commander of the 59-day Skylab 2 space station flight, one of the longest and most productive U.S. voyages. But his muse hadn't departed for good. Bean resumed art studies under the guidance of Houston artists Evelyn Stebbins and Artis Settle, and held his first exhibition in 1974.

Like flight testing, a good painting is a product of trial and error. "It takes a lot of experimenting," Bean says. "It's not like when an instructor can tell you step by step how to fly an airplane. An artist can tell you how to be an artist until you're about half way there. Then, because they don't know or can't explain the other half or just won't tell you, they resort to what people have always done when they couldn't explain something: give it another name, like 'magic' or 'talent' or 'a natural feel for color.' "

Although his space flights provided stark and spectacular vistas, Bean didn't really entertain the idea of painting those scenes at first. Instead, he did still lifes, landscapes, and copies of impressionists. "People kept asking if I did moon paintings," he recalls. "I'd say no, I wanted to be an impressionist painter, and the moon is gray, the sky black, and the space suits white. There were none of the beautiful colors that you see in Monet's work. But one day in 1974 I had nothing else in mind, so I started a lunar painting. After about three hours I realized that this was what I should be doing. I knew only the basics about water lilies and flowers. But when I painted a space suit, I knew everything about it, and I loved it."

Inspired by American painters Charles Russell and Frederic Remington, who chronicled the Old West, Bean began rendering his knowledge and love of the Apollo program in an acrylic-on-Masonite medium, chosen for its state-of-the-art technology and durability. "I'd look at Russell's and Remington's paintings while I worked to see if my spaceships looked as good as their horses. They didn't—but they do now."

Getting there wasn't always easy, Bean remembers, especially learning how to capture the subtleties of white space suits and the gray lunar surface. "I'd think I had the world's greatest painting and I'd take it to another artist, Lajos Markos, who'd say, 'It needs more color.' So I'd bring it home, add some, and it would look *too* colorful. I'd take it back to him—'Add some more,' he'd

Collection of Barbara Whitney

The Hammer and the Feather

"Galileo's discovery that 'gravity pulls all bodies equally regardless of their weight' was vividly demonstrated by Apollo 15 astronaut Dave Scott before a television audience that spanned the planet Earth."

When not in use as models, Bean's Skylab gloves and shoes and Apollo tools decorate his living room.

say, 'and let it sit for a week.' "

Two weeks later, both the painter and the painting would have softened. "There's an old saying that the most important tool an artist has is not a brush or a palette but a chair, where you can sit and look at what you've done," Bean says. "And it's true. Now I use every color in the world in what looks like a white suit." Indeed, the suits and the lunar soil range from deep purple to rose to turquoise, but appear to be simply varying shades of gray and white.

Bean continued to paint while training future shuttle crews. He also began to think about becoming a full-time artist. "I'd take two weeks' leave and just paint, trying to simulate the life of an artist," he says. "I thought, *Maybe I'd like it as a hobby but not as the real thing.* But the more I did it the more I liked it, and found I *needed* to do it. There's people who can fly the shuttle better—and worse—than me, but I'm the only artist who's been to the moon and can share its beauty. I know the stories, the people, the hardware. So the decision was that simple."

In 1981 Bean resigned as chief of astronaut training for NASA. It was a radical career change for someone honed on the cutting edge of flight technology and the fourth of a dozen people to set foot on the moon. "Are you sure you can

Senator Schmitt Samples Subsurface Soil

"Harrison 'Jack' Schmitt is taking a scoop of lunar material from a small crater while Apollo 17 commander Gene Cernan prepares two sample bags. Jack was a superb scientist. After the Apollo program, the people of New Mexico elected him to the Senate."

Eight-hour days at the easel produce about one painting a month, though several are in progress simultaneously. A stickler for detail, Bean applies a seemingly endless series of finishing touches.

Collection of Kenneth McCann Jr.

make a living at that?" fellow astronauts asked. Bean wasn't sure, "but I figured that if I didn't make enough money to eat, I'd go work at Jack-in-the-Box."

Today Bean works not at a fast-food counter but amid the comfortable clutter of a condominium shared with his wife Leslie—who calls him by his Navy nickname, Beano—and a herd of Lhasa apso show dogs. "I like the size of this place," he says, threading his way around furniture, stooping to pet the dogs as they jump up to greet him, "even though it's 2.6 percent smaller than Skylab. When I do a big painting it seems crowded, but I feel good here." Paintings to be exhibited lean against the Caribbean-blue walls, hang over the fireplace, rest on the desk: the artist tinged in golden tones and gamboling in the moon's reduced gravity, a dream-like lunar walk awash in pastels, the space shuttle *Columbia* lifting off the launch pad at Cape Canaveral into the rich blackness of night.

Remembrances of his voyages into space and throughout the world are scattered around the rooms like shells on a beach: Skylab gloves and worn shoes, a coring device used to extract lunar soil, a piece of amber from Russia, a shard from the Great Wall of China. Ivy from Monet's garden and greenery from van Gogh's grave grow in small pots on the porch—"I brought back enough to give to my art friends and instructor." Photographs, awards, and early paintings highlight his NASA career: "To Alan Bean: The Broken Brownie Award—for his unique and exciting camera contacts," reads one citation. "I got that for breaking one camera and messing up another coming back from the moon," he says. A NASA plaque bearing freeze-dried spaghetti is hanging near the refrigerator, which is

Collection of Alan Bean

Tiptoeing on the Ocean of Storms

"It seemed I could run forever on the moon and my legs would not get tired. You quickly learn to run differently in a space suit by keeping the legs stiff and using ankle motion. It looks—and feels—like dancing on tiptoe."

On the Rim

"Apollo 16 astronauts John Young and Charlie Duke, with the rover, have just arrived on the rim of North Ray crater. Charlie later reported, 'I wasn't going to get close enough to see if the bottom was visible because there was no way I could have gotten out if I fell in.' "

Collection of Richard Harris

That's How It Felt to Walk on the Moon

"I began this painting about a year ago, but when it was nearly completed I didn't get the right gut reaction to it. I set it aside for a while but studied it every day. A new vision emerged, one that elicited more exhilarating emotions. This is the result."

Collection of Barry Wright

In a small porch garden of tribute and inspiration, ivy from the garden of Claude Monet, Bean's favorite artist, grows with greenery from Vincent van Gogh's grave.

The Eagle Is Headed Home

"Apollo 11 has just lifted off from Tranquility Base en route to the command module. On Apollo 12, I recall a ring of bright flashes of the insulation being blasted from the descent stage. It reminded me of the effect of dropping a rock into calm water."

Collection of Overton Park National Bank

covered with pictures of Leslie and the two Bean children. "I was the first person to eat spaghetti on the moon," he laughs. "I'm tempted to have that put on my tombstone."

Sitting in a corner of the den is one of his first works, a mosaic entitled "The Spirit of Flight," which suggests an object, a soul perhaps, rushing up into the void of space, propelled by both technology and the spirit of exploration. "I hung it horizontally back when I was a test pilot," Bean says. "When I got to be an astronaut, I turned it vertical."

In the living room, a stack of 45s sits by a record player. "I like certain songs," Bean says, shuffling through the pile and selecting a sample, "and I don't want to listen to the whole dang album to get to them." A hit by Culture Club starts up—"On this one, I like the beat." The record player is usually on while he paints, the 45s dropping one after another.

The work in progress is "The Hammer and the Feather," a large painting that depicts Apollo 15 astronaut Dave Scott dropping both objects on the moon to show that they fall at the same rate in reduced gravity. Accuracy counts as much as aesthetics to Bean, so he spends much of his time studying photographs, drawing maps of lunar panoramas reflected in a helmet visor, and borrowing clothing and tools from NASA, often a problem because the agency dispenses most of its space artifacts to museums soon after their return to Earth.

"I'm going to NASA tomorrow to get a good view of the hammer, but the feather . . . " Scott used a falcon feather for his demonstration, so Bean is on a wild falcon chase. He called the Air Force Academy, which uses falcons as mascots. Academy officials referred him to the U.S. Fish and Wildlife Service in Denver, because the falcon is protected and even its feathers are under government aegis. The agency knew of a falconer in San Antonio who had collected enough feathers to build his own bird. But as bureaucracies are wont to do, the agency required complicated forms to be filled out before it would loan a single feather. "I'm still waiting for the forms," Bean sighs, as the deadline for an exhibit at the Meredith Long Gallery in Houston draws near.

Bean works on several paintings simultaneously, and completes one a month by working at the easel for five or six eight-hour days a week. Some paintings are sold at exhibits, others are commissioned. Buyers include Joseph Imparato, an art collector in Richmond, Texas, who in 1983 bought Bean's first work, "Too Beautiful to Have Happened by Accident," which shows astronaut Gene Cernan, the flag, and the Earth high overhead. Imparato, who also owns paintings by Leroy Neiman and Norman Rockwell, says he was drawn to Bean's work not only because of the artist's Apollo background but also by the quality of the painting. (Boxer George Foreman has a print of this painting hanging in the entry of his private gym.)

Chuck Allen, president of Sloan Valve in Chicago, doesn't fancy himself a collector. But he read about Bean's art in *Time*, attended an exhibit in Houston, and bought five paintings. "He's a unique artist painting in a unique time," Allen declares. And Allen Neuharth, chairman of Gannett, the country's largest newspaper chain and publisher of *USA Today*, has a single painting hanging in his mammoth office overlooking Washington, D.C.—Bean's "For One Priceless Moment." It depicts Neil Armstrong and Buzz Aldrin planting the American flag near the lunar lander *Eagle*. "I'm intrigued by American artists," says Neuharth, "and what could be better than a former moon astronaut's work? He paints as one who was there—his footprints, his shadows."

Of the more than 50 paintings Bean has offered for sale, only a few remain unsold. He does not choose to sell all his work, however. "I keep the ones that have something I especially like, such as the really colorful dirt here or this shadow—see how transparent it looks?" he says, pointing to a blue shadow cast on Scott's suit by an oxygen hose. "It'll be hard to give this one up. Most artists say the one they're working on is their favorite, but you have to move it out and start another that you'll like even more."

Although he regularly sees former coworkers at reunions, none of the Apollo astronauts has bought a painting, which does not surprise Bean. "Most astronauts don't see $12,000 there," he explains, gesturing at a painting on the

A sleek blue Trans Am with gold wheels proves to be an ideal transport for larger paintings—and for its Pontiac fancier.

wall. "In fact, most people don't. Only a small percent of the population buys original art. I wish some of the astronauts would buy one, though—I think they'd be real happy with it."

One coworker he'd like to see more of is also a space artist. Aleksei Leonov, the first man to walk in space and later the Soviet commander of the Apollo-Soyuz mission, has visited with Bean several times here and in the Soviet Union. They met during Bean's assignment as one of the project's back-up commanders. The pair held an exhibition of their paintings at the Scientific Museum in Paris in October 1985. "I later sent him a box of art supplies and some really nice brushes," says Bean. "And he sent me a Russian-made easel. He's just the nicest possible guy. But he doesn't have the time to paint anymore because he's the deputy director of the space flight training center."

Interpreting the history of the space program is a lifelong project, and Bean has enough planned to keep him busy at least that long. "I feel I only have a certain number of years left to do this job—hopefully about 20—and I want to make the time count. And I think when I work at painting, my time counts."

Although he would love to fly a shuttle mission, Bean says he'd decline if offered a slot as part of NASA's plan to send writers, artists, and musicians aloft (which is now on hold until the shuttle's future is defined more clearly). "I'd recommend that NASA take other artists so *they* can have the experience and come back and paint. I've had more than enough to use the rest of my life. It would be a shame to give me more."

Most of his work has centered on the Apollo program; he has yet to paint a scene from the Skylab mission. "People are attuned to this part of history," he says, touching the Scott painting. "I'd also like to do a complete show of Neil taking the first step on the moon, interpreting it in different ways—realistic, impressionistic, greens and blues, close up, far away." He also hopes to talk to astronauts outside the Apollo program and paint the stories of their missions. "I'd like to preserve history by becoming a sort of tribal storyteller."

Alan Bean is one of those rare people who not only accomplish everything they set out to do but appreciate every step of the journey. "It's not that I was gifted as a naval aviator or an astronaut," he says. "I daydreamed about what my life should be like and then paid whatever price it took. Today I have the nicest possible life. There's my wife, my children, my dogs—and my painting. Nobody hassles me. All I think about is how to make something more beautiful and more striking than it already is.

"My goal now is to be remembered not as an astronaut but as a space artist," Bean says. "After I'm gone, people can decide if my pictures are beautiful enough to represent history." ✈

Five Lhasa apso champion show dogs—and an occasional litter—make space a premium item in Bean's condominium/studio, which is "2.6 percent smaller than Skylab."

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MCDONNELL DOUGLAS

The Little Airline of the Lake

With this offshore service, no man is an island.

by Margaret Engel

Robert Lightfoot III

Pilot Cindy Dages "pre-flights" airplane and passengers in a ritual that lasts longer than the trip (above).

Groceries and dog food are standard freight on flights that link Lake Erie islanders to the mainland (right).

Matthew Trumpower was stuck indoors. The two-year-old resident of Middle Bass Island in western Lake Erie had left his snowsuit and rubber boots at the home of his grandmother, a mainlander, and now Matthew and his winter clothes were separated by several miles of ice.

But Mary Lesczynski had a solution: she bundled her grandson's belongings in a grocery bag and headed for the counter of Island Airlines. With its brief flights—the longest is only five minutes—this no-frills airline serves as school bus, commuter ferry, and supply truck for the trio of Bass Islands, which provides wine, fish, and getaway weekends to mainlanders. For $1.75, the boots and snowsuit were on the way to an anxious Matthew.

Scenes like these are played out every day at an airline that seems a half-century removed from the pace of Cleveland's Hopkins International Airport, just 60 miles to the east. With its 30-year-old de Havilland Otter and four assorted Cessnas, Island Airlines seems more suited to the remote terrain of Alaska than to the tiny dots of land just a few miles from the comforts of Port Clinton, Ohio. But for the 500 residents of North Bass, Middle Bass, and South Bass Islands—named for the once-plentiful prize catch—the homespun airline is a lifeline, a triumph over geography.

"It's my backbone," proclaims ruddy-faced Pat Chrysler, who earns part of his living shepherding fishermen over the frozen lake four months out of the year. "If there are no airplanes, there's no fishermen and no food." More than a dozen guides work the islands, escorting mainlanders who spend the day fishing, eating, and drinking inside one of the heated shanties that dot the ice. In the prime ice fishing weeks in January and February, up to 100 visitors a day—and 300 each weekend—pay the $20 round-trip fare and another $25 for the services of a guide. The attraction is "jigging for 'eyes," or bouncing lures on the lake bottom to entice choice walleyes and perch.

Robert Lightfoot III


EXIT
KID'S
Love Me Tender
Elvis Stay Med

Robert Lightfoot III

Ice fishing guide Mike Massie displays the islands' main economic draw in winter, when the airline brings hundreds of visitors a week in search of walleyes.

Perry's Victory Memorial on South Bass doubles as Island Airlines' visibility gauge: "If you can't see the monument, don't fly" (below).

Terry E. Eiler

Lyntha Scott Eiler

Three wineries produce more than 800,000 gallons of the islands' main export each year. In the winter, vines are trimmed to encourage summer growth.

"It's cold and drafty and noisy inside the planes, but you learn to love that sound," says South Bass resident Jo Ann Robison. Her two children, like most on the islands, flew before they could crawl. Many make their first flight only hours after birth, a trip home from the hospital on the mainland.

In addition to its lifelong clientele and its size—the company bills itself as the world's shortest airline, although it is officially considered an air taxi service—Island Airlines holds the distinction of having used Ford Tri-motors long after others relegated them to museums. The Tin Goose, manufactured by the auto baron in the late 1920s and early 1930s, was nicknamed for the way it waddles while taxiing as pilots S-turn to improve visibility over—and under—the Wright Whirlwind radial engines.

Esteemed by a generation of early airline pilots for its dependability and sturdiness, if not for its plodding 90-mph cruise speed, the corrugated-metal airplanes were also called Flying Washboards. Their generous wingspan made them a perfect match for the short grass runways on the islands. However, the July 1977 crash of the airline's last Tri-motor ended the nostalgic flights for Ford fanciers and commuters alike. Airline manager Dave Martin piloted the Tri-motor that sad afternoon. "It was a fuel problem that was never pinned down," he recalls. "We had failure in all three engines." He suffered a broken back and spent a year recovering. The Tin Goose was rebuilt for $300,000 and sold to a pilot who uses it in barnstorming shows on the East Coast.

Today Island Airlines runs up to a dozen flights from Port Clinton to the islands, operating every day except Thanksgiving, Christmas, New Year's, and Easter. The Cessnas—172s and 207s—and the Otter carry three to nine passengers each. Pets can join their owners aloft for $2 round trip. So many canines show up during hunting season that they must be carefully situated about the cabin to avoid aerial dogfights.

During the summer, when an influx of tourists swells the islands' population to 50,000, two ferry services augment the airline's daily flights, and most commuters switch to the boats. But freezing temperatures propel traffic back to the airplanes each fall. During busy periods, says Martin, "the wheels don't stop spinning before we're landing on the next island." The airline employs four full-time and four part-time pilots, including Randy Gorman, 35, who farms when he isn't flying. "It's sort of a weird combination of jobs for people to accept," Gorman says, "but it makes sense to me." The maintenance crew consists of Ed McGuire, an ex-military mechanic, and his two sons.

There is no control tower or sophisticated weather reporting system at Port Clinton or on any of the islands: Perry's Victory and International Peace Memorial, a 352-foot Doric column on South Bass, serves as a visibility gauge. The granite monument honors Commodore Oliver Hazard Perry—"We have met

Robert Lightfoot III

Students fly to island schools on the Otter, but switch to ice buggies when the winter weather turns bad.

the enemy and they are ours"—and the American and British sailors who lost their lives in the Battle of Lake Erie in 1813. Pilot Cindy Dages sums up the airline's weather rule: "If you can't see the monument, don't fly."

Long before People Express trained each employee to handle several jobs, the crew of this airline was performing tasks far removed from piloting. The runways on North and Middle Bass are often so muddy and rutted that pilots—and sometimes passengers—have to climb out and lift the airplane's tail around to line up for takeoff. And everyone pitches in to handle freight, which includes bags of mail, crates of wine from the islands' three wineries, snow-

mobiles, jackhammers, dishwashers, and occasionally a body bound for an island cemetery. Jeanne Berry, a postal service employee on South Bass, lifts weights and leads an aerobics class at the town hall to keep her back in shape for the odd and cumbersome cargo the airplanes disgorge. "The federal government once sent three dozen large pine trees for the monument grounds," she recalls. "And I hate when I have to haul out transmissions."

Dispatcher Sue Crosby has to be adept at much more than scheduling. She's now an expert in removing fish odor from the airplanes. Her method? "Straight Lysol." Island Airlines employees are unfazed by workdays that include everything from shoveling snow to hauling animals to a mainland veterinarian. "I was warned this wasn't a desk job," Crosby says.

The airline is viewed with a kind of hometown goodwill that is unfamiliar to most of commercial aviation. Guide Sue Riddle credits the airline with saving the ice fishing industry three seasons ago, when the supply of gold minnows used for bait dropped drastically. The guides organized the Great Minnow Fly-In, in which the seats of the Otter were removed for buckets of the small fish. "After the Otter landed, we set ourselves up like a fire brigade to haul out the buckets and keep the minnows alive," she recalls. "We all would have been unemployed that winter without the fly-in."

Personal service unheard of elsewhere is the norm here. Islanders could once call the airline with a grocery order, which would be filled and flown in for a 25-cent fee. Shopping service was discontinued in the 1960s, but the dependency remains. "Everyone's refrigerator has a list on the door because you can't just turn the plane around if you forget something," says South Bass resident John Blatt, who flies to his mainland job daily, frequently carrying the family's dry cleaning in garbage bags. Like most island residents, he keeps a car parked at Port Clinton airport each winter for $15.

One recent winter morning three high schoolers sat in the unheated cabin of the Otter as it snarled over Lake Erie at 1,500 feet. In the aisle sat cartons of eggs destined for an island general store, and large canvas bags of freshly caught walleyes filled the rear cargo bins. Shouting over the engine noise, the students crammed for an English literature test.

Robert Lightfoot III

At Kamille Allen's one-room schoolhouse on North Bass, airplane engines serve as the morning bell.

"People don't believe me when I tell them how I get to school," says Arlene Wolf, who has never ridden in a school bus. "It's hard to convince them I fly to my classes." The students fly from Middle Bass to Put-in-Bay airport on South Bass, where the island's only taxi transports them to school. Ohio taxpayers finance these arrangements as part of the state's educational obligation.

A later flight brings elementary school teacher Kamille Allen to Ohio's last one-room schoolhouse, located amid the rows of grapevines on North Bass, which has a population of only 27. The school houses a small library, computer, television, and a seven-foot papier-mâché dinosaur. There's also a kitchen, shower, and pull-out couch, which Allen uses when bad weather strands her on the island.

A spirited instructor, Allen taught on the mainland for 19 years before moving offshore four years ago. She presides over four students for most of the school year, and four to six children of migrant vineyard workers join the group in the spring and fall. Using engine noise as a warning bell, the children walk the deserted roads to meet her at school. A dog customarily accompanies them and patiently waits outside the schoolhouse door until its owner emerges for recess.

Because the classes are so small, the children, aged 6 to 13, essentially receive private tutoring, which seems to suit them fine. "I like not getting lost in the hallways of a big school," says Gilbert Marez, 13, whose nephew at a Port Clinton school tells him of having his belongings stolen from a locker. "I'd like to have more friends and play football and wrestle, but there's something special about coming from an island."

Adult islanders agree. "It's very safe here," says postmistress Herma Dopps, a North Bass resident since 1976. "No one even has keys to lock their doors, and everyone leaves their car keys in their cars."

Few professional services exist on the islands, so bank tellers, speech therapists, telephone repairmen, and computer technicians all regularly board the flights from Port Clinton. Medical help had been especially needed until township trustee Dale Burris recruited 31-year-old osteopath William Schlotterer two years ago.

Schlotterer, who maintains a practice in the mainland city of Huron, relishes his weekly aerial assignment. "I'm a thrill junkie," he concedes. Given to wearing a leather aviator jacket and Indiana Jones-style fedora, Schlotterer claims the flights are "better than Cedar Point," the popular Ohio amusement park. Squinting at the glistening lake, he amuses his fellow passengers by singing, "On a clear day, you can see Toledo."

The doctor carries a shaving mug and toothbrush in his medical bag—he can count on bad weather several nights a season. Schlotterer sees patients in an office in the South Bass home of Bryan Sloan, the island's paramedic, and also makes house calls like a country doctor of yore. Because there is no facility to test cultures and blood samples, Schlotterer transports them to mainland laboratories: "I use a lot of catch-all antibiotics in the first days, before I can get the cultures tested." He and Sloan race to emergencies such as chest pains and ice rescues in a bright yellow van or an all-terrain vehicle.

In the years before air travel, passengers and supplies reached the islands in winter via 18-foot "ironclads," narrow metal boats on runners. They were pushed from island to island, often by young ferry workers who wintered over. The invention of the Model T Ford popularized ice buggies, open-air vehicles cut down from automobiles that could cross the lake after a decent freeze. Trustee Burris, who is also superintendent of the Meirs Winery on North Bass, is a third-generation islander who owns a 1928 Model A Ford ice buggy. On foggy days that ground flights, Burris drives the islands' children to their schools and hauls groceries for neighbors in need.

Snowmobiles, bicycles, and even brisk walkers can also make the two- to three-mile trips between the islands, but not without risk. Unpredictable storms and fog can quickly disorient even the most experienced crosser. In February 1986, a 17-year-old drowned on his way home to Middle Bass after visiting friends on South Bass. He apparently strayed into an area weakened by a recent thaw, and his snowmobile broke through the ice.

To minimize such hazards, islanders mark paths across the ice by chopping holes in it and placing their used Christmas trees in them as markers. From the air, passengers can see tinsel twined in their branches. Fishing shanties are clustered along these ice highways like haystacks in a silver field.

The credit for moving islanders from water to air belongs to Milton "Red" Hersberger, a former barnstormer from Chicago, now 85 and living in Port Clinton. He began the Erie Isle Airways Company in 1930 and acquired his first Tri-motor two years later, when he bought one that had crashed in the mountains near Pittsburgh. The fleet soon increased to five, and the airplanes' longevity was considerably extended when Hersberger bought several hundred surplus engines for parts after World War II at $15 each. The airline changed hands in 1953 and again in 1973, and it now belongs to two attorneys and a retired accountant in Mansfield, Ohio. The corporation also runs a flight school at Port Clinton airport.

Island Airlines customers are grateful for the daily connections to the mainland, but relish their relative remoteness from full-blown civilization. Dick Dysart, driver of the Put-in-Bay Cab Company's sole taxi, fled to the islands from Ottawa, Ohio, where he and his wife Marge worked for 11 years in a factory assembling picture tubes for television sets. "It was total stress and we hated it," he says. "We're in our own world now—we don't even get called for jury duty out here."

Jo Ann Robison, who has lived on South Bass for 18 years, is equally satisfied with island existence: "I've learned over the years there isn't anything so important that it can't wait until tomorrow's flight."

Ford Tri-motors served the islands for 45 years, until the last Island Airlines Tin Goose crashed in 1977.

Terry E. Eiler

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Clearing the Sky

Calling the science of Earth observation an industry didn't make it a good business. But with a fresh approach and global ties it could both survive and thrive.

by John H. McElroy

Satellites are our highest platforms. They offer us the vantage point of a taller pole from which we can observe or communicate over wide areas of the Earth. What distinguishes them from other parts of our space program is that the satellites produce a direct economic benefit. Most other space activities are aimed at expanding our knowledge or appealing to our collective sense of adventure, but they produce only indirect economic benefits. We plan expeditions to Mars in order to explore, not to profit.

The report of the National Commission on Space is a plan for adventure, and one is hard pressed to find in it any reference to economic benefits of the programs it advocates. Of course, the commission's aim was to stimulate the human spirit. It wasn't charged with writing a business plan.

Just because consideration of economic benefits is not part of some programs, there is no reason to exclude the subject from all planning. But for the past five years, consideration of economic benefits has been absolutely and deliberately excluded from our efforts in space-based Earth observations and space applications such as manufacturing.

Ironically, Earth observation is one of the great success stories of the entire space program, but its very success has worked against it. The magnitude of its contribution and the pervasiveness of its applications are so great that too many people have lost their appreciation of its benefits. As a result, one of the only aspects of the space program that produces a direct payback is floundering in a morass of indecision and misperceptions based on obsolete notions.

At the very center of this trouble is the transfer of the Landsat Earth observation satellite system from government, which launched it, to the private sector. Since the last years of the Carter administration, when the idea for the transfer was born, the federal government, led by the Office of Management and Budget (OMB), has sought to prevent Landsat from becoming another costly permanent government operation like our weather satellites.

Federal policymakers were also persuaded to favor the transfer by the claims of Landsat advocates who, in pressing for continued funding for the program, promised huge commercial markets for the system's product. Those claims ultimately led to a decision to transfer this "valuable" property to private industry. In formulating policy, the issue of maintaining a continuous flow of data was sidestepped. If the private market is so enormous, the reasoning went, the government should be a minor player, certainly not a guarantor.

Early claims for the size of the private market were excessive, of course. And government agencies' refusal to guarantee any purchases of Landsat data from a private company obscured the role of such data as "public goods" accessible to all and permitted the government to avoid any responsibility for ensuring its continued supply.

The Carter administration said that 10 years of transitional support would allow sufficient time for the private sector to gear up to take over Landsat. Four additional satellites would be added to those already in orbit to complete the system. The Reagan administration cut the number of satellites to be launched, eliminating the possibility of maintaining the supply of data upon which so many private investments would rely. Shaken, potential customers put their plans on hold.

At the same time, the OMB directed the National Oceanic and Atmospheric Administration, which was managing Landsat during its transition period, to raise prices for the data. Then the OMB restricted the budgets of federal agencies that used the data, forcing them to focus on sustaining their present programs at the cost of their future plans. But these agencies were the same ones that most needed Landsat's product in order to fulfill their governmental duties: the Departments of Agriculture and Interior, the Agency for International Development, and various Defense agencies. While private applications certainly existed—mineral and energy surveying, for example—the data Landsat provided was simply a more sophisticated form of the mapping data governments have gathered for centuries. To ignore the hybrid public-private nature of Earth observation and deny the government's need for the data is intellectually obtuse.

By refusing to acknowledge that Earth observation data

were "public goods," the OMB ruled out the possibility of minimum government support for a private Landsat venture. When a private market failed to appear promptly, it was too late to change things. The OMB was able to argue successfully that if no private market existed to sustain the operation, then Earth observation probably shouldn't have been part of the space program in the first place.

This policy rift, combined with a leadership vacuum, has caused the EOSAT Company—the newly formed firm that won the hard-fought competition to take Landsat private—no end of difficulties. It still lacks any firm commitment of federal support for more than a month at a time, and since its formation, support has dropped, not risen. Its most visible competitor, the French SPOT system, faces no such adversities.

While Landsat suffered, science and technology advanced. Weather satellites became an entrenched institution, saving lives and money. The individual systems launched by Europe, India, Japan, and the United States collectively make up a ring of stationary weather satellites above the equator that provide images to worldwide users. U.S. and Soviet polar orbiters at lower altitude fill in the blank spots and add atmospheric measurements. More than 140 nations use these services daily.

To ignore the hybrid public-private nature of Earth observation is intellectually obtuse.

But over the years, a funny thing happened to weather satellites: they began mapping ocean currents, glaciers, snow fields, drainage basins, and floods. The "weather" sensors could even produce maps that showed the effects of drought, seasonal changes, and trends from year to year. Without anyone's noticing, they had become weather-ocean-land sensors. Combined with Landsat data, the maps from weather satellites created powerful tools for studying Earth. But what to label these new tools? Categories became meaningless at a rate that outpaced policymakers' ability to keep up.

The traditional division between "operational" and "research" instruments was also rapidly crumbling—a division that had, in any case, always been vague. Research instruments are producing data spanning decades, with advanced analysis, archiving, and distribution networks, all of which bears a stunning resemblance to an operational system.

The complaint that there is no viable market for a private Earth observation venture has almost become scripture. But if Earth observation as a whole is considered, it is patently untrue. If you limit the definition of an Earth observation system to one that uses only Landsat-type sensors, that is confined to its own platform, and that has its own data processing network, but then deny it support by government purchases and allow that same government to distribute similar data free of charge, you've described a truly bad business venture. Eliminate the artificial restrictions and a different picture emerges: private and government sensors sharing satellites, two government agencies sharing a platform—probably far too radical an idea—or even a government that buys data from private sector satellites. Now you're talking business.

There is little question that economies of scale would bring costs down and that the domestic market would be very large indeed. More intriguing, there would be an even larger global market, and its precedent can be seen in Intelsat and its U.S. affiliate, Comsat, which have provided global satellite telecommunication service for over 20 years. Earth observation is an inherently international activity that fits the Intelsat model. We could create an international management company I'd like to call Envirosat International, and a U.S. entity, Envirosat USA. They would provide unified international weather, ocean, and land data services in the same way Intelsat handles telecommunication.

Arguments against private operation of Earth observation always point to the threat to individual nations' security from orbiting sensors overhead. The subject came up in 1960, when the first weather satellites "threatened" to recognize objects 1,000 meters long. But last year, when SPOT sent back images with 10-meter resolution, there was barely a murmur. It seems that if the data become available to all through a multinational operation, such worries will vanish.

I am optimistic about privately operated Earth observation. Free of old restrictions and antiquated policy, such a venture could thrive. Our government is resilient and can correct its past mistakes. In fact, nothing exercises that resilience like a sharp jolt—which we're about to get.

The space program will soon have something it has always wanted: a space station, with unmanned co-orbiting and polar-orbiting platforms for Earth observation. Both are actually large, tended satellites. When they were first proposed, the two platforms were perceived as some form of decoy to distract science and applications proponents or even as padding to compensate for future budget cuts, but the platforms have now taken on a life of their own.

The National Oceanic and Atmospheric Administration likes the polar orbiter for its weather instruments, and it has sought—and obtained—worldwide support. The European Space Agency led the rush, offering the National Aeronautics and Space Administration a complementary polar platform that would create a dual system with enormous observational power. Neither NASA nor ESA is really up to the task of operating a $1 billion system with a service life of 20 years, but the private sector might be. Intelsat comes to mind again.

Earth observation is on the threshold of greatness. We can observe the entire globe, issue warnings before disaster strikes, evaluate environmental trends, and produce scientific insights into our most important planet. This achievement is within reach, and both public and private sectors can participate by doing what each does best.

We should go to the moon, and then to Mars, and onward to the stars. At the same time, we should not neglect the space spectaculars that serve us so well—the ones directed at our own planet. Space applications must be an integral part of our space program. Partnerships between government and industry need the same fresh thinking we give to ventures in space science and exploration. We must dream not only of the stars, but of the Earth.


KA-9


12

Soaring on the Sea

by John Rousmaniere

Illustrations by Pierre Mion

In the two years before the 1983 America's Cup elimination trials began off Newport, Rhode Island, an aerodynamicist named Arvel Gentry spent 1,400 hours designing keels for a 12-meter yacht that would vie for the right to represent the United States. Two moments stand out in his memory.

The first occurred in late 1981: "A bunch of technical people interested in helping yachtsman Dennis Conner got together in my house one weekend for a brainstorming session," recalls Gentry, who works at Boeing. "I asked them, 'What kind of weird things can you put on a sailboat to make it perform better?' They came up with all sorts of ideas from aerospace technology. We had O-shaped keels resembling the ring wings used on aircraft. We had tandem keels. We had winglets—a pair of small wings affixed at right angles to the keel's tip. I decided it would be a good idea to look at the 12-meter rules to see if any of these things were legal."

Gentry got as far as Rule 27, which said that "peculiarities" in a boat's construction would not be tolerated. He concluded, unfortunately as it turned out, that winglets were peculiarities, and he returned to traditional approaches. The keel and mast on *Liberty*, a boat designed for Conner by Johan Valentijn, showed Gentry's influence.

Gentry's second memorable moment occurred early in the summer of 1983. The Australian 12-meter *Australia II* arrived in Newport with a shroud around her keel—and proceeded to overwhelm the other yachts in the preliminary races. Finally, her secret leaked out: *Australia II*'s keel had winglets. "Winged keel" became a household—or at least a boatyard—term overnight. Remembers Gentry, "When Johan called from Newport to say that *Australia II* had wings, I said, 'Oh my God, we're in trouble.' "

As strange as *Australia II*'s keel looked, its winglets turned out to be not so "peculiar" after all. Similar devices had been tried earlier on at least one other boat, and in the 1960s Olin Stephens, an American naval architect regarded as the dean of the world's yacht designers, had experimented with endplates, a poor relation of the winglet, while testing models. But Stephens had rejected the idea when experiments indicated that the keel's increased surface area caused unacceptable drag.

The New York Yacht Club, which administered the Cup, did its best to disqualify the radical Australian boat, but Stephens privately congratulated its designer, Ben Lexcen, for the innovation. The matter was settled for good when the sport's ultimate governing body, the International Yacht Racing Union, disclosed that it had approved the concept a year earlier—at the request of the British, not the Australians.

Gentry's fear was ultimately borne out: *Australia II* took the Cup, and the big trophy left the United States for the first time in 132 years.

Lexcen claimed credit for the keel—he had to, since Cup rules require that each boat be a product of the nation it represents—and he probably was responsible for deciding its ultimate shape. But the keel was in fact the work of the international aeronautical research community, focused through the Netherlands' Nationaal Runtevaart Laboratorium (National Aerospace Laboratory). A final irony added to the indignity of the Americans' loss: the theory behind the winged keel is the work of a U.S. scientist. Richard T. Whitcomb reported in a technical paper written in 1976 for the National Aeronautics and Space Administration that winglets significantly increased an airplane wing's effectiveness in wind tunnel tests.

While a few innovative designers perceived a natural link, relations between aviation theorists and yacht designers typically remained distant and informal—until recently. The relentless development of relatively inexpensive but powerful computers that can run basic aerodynamic and hydrodynamic software has brought both fields together. Now both share the same tools and, to a greater degree than ever, speak the same languages.

Still, it would be a mistake to say that scientists "designed" the 12-meter yachts now racing. "We can't do a complete model of a yacht on a computer," says Valentijn's assistant, Rik Van Hemmen, a graduate of Virginia Polytechnic Institute's joint program in aerospace and ocean engineering. "A yacht is more complex than an airplane because the sails are soft, because there are waves, and because a sailboat changes how it leans with the wind. But we *can* do very accurate performance analyses of keels."

Despite—or perhaps because of—what happened in 1983, Gentry reappeared to help Valentijn design the keel

Yachtsmen strain to catch every breath of wind and any innovation that might help them win races.

You don't have to look hard to see bits of airplane in every sailboat.

for *Eagle*, a California entrant in the current Cup races in Australia. Using a variety of computers and programs, he designed some two dozen keels. "I'd sit down after dinner and start a configuration," Gentry says. "By the following day I'd have complete pictures of a keel's shape, which I could then test using fluid dynamics software." Valentijn built models of some of the keels for testing in a water tank, ultimately selecting the best keel-and-hull combination. But *Eagle* didn't fly: she never made it to the finals.

Aerodynamicists working with the other four U.S. 12-meter syndicates were also playing freely in the dynamic field of keel design that had surfaced in the wake of *Australia II*'s victory. Of the estimated $65 million that U.S. syndicates spent on the current race, about $15 million went for designing the boats, and a good chunk of that went directly into research on keels.

The most radical yacht in this year's race is the surprisingly successful *USA*, developed by Gary Mull of Oakland, California, and a team of aerospace engineers. They fashioned a hull with a torpedo-shaped lead keel, dubbed The Geek, that helps *USA* resist heeling over in heavy winds. Even more startling is the arrangement of rudders in the bow and stern that makes *USA* especially nimble in turns. The dual-rudder system mirrors the canard wing arrangement—the "little wing" up front—seen on some airplanes.

Of course, an aerodynamicist can't just sit down at a computer terminal and turn out a winning yacht. The design process is vastly complicated by the fact that sailboats, unlike airplanes, function in two elements: they are propelled by the wind but they glide through the water. So challenging is this problem that theoreticians refer to it by a formal name, the Ancient Interface.

The ideal sailboat would have minimum resistance at the interface itself—where water meets air. The perfect combination of shapes would eliminate the hull entirely: reduced to its essentials, it would consist of a mere keel beneath the water's surface that is towed by a kite aloft. Assuming the crew needs a place to sit, though, a more practical solution is a sailing hydrofoil: a hull equipped with small wing-like surfaces that lift the entire boat when it's under way, reducing the water's drag and enabling the boat to attain very high speed.

In fact, one of the most ingenious vessels developed in the past few years is a catamaran hydrofoil towed by a sophisticated kite, which pulls the twin hulls up rather than pushing them down as a normal sail would do. Called *Jacob's Ladder III*, this sublime boat has been timed at more than 15 knots, or about 17 mph—roughly twice as fast as a 12-meter.

Such newfangled contraptions notwithstanding, sailboats have been around much longer than airplanes, so the relatively young science of aerodynamics encounters centuries of tradition when it brushes against marine architecture. One of the first sailboat designers to tap into aerodynamics was W. Starling Burgess, who built seaplanes under license from the Wright brothers and also built yachts in the 1920s.

His greatest successes were the schooners *Advance* and *Niña*, whose tall, powerful sails overlapped slightly. This "slotted wing" arrangement was inspired by airplane wings with leading edges that provide a slot through which air from the wing's lower surface can pass to its upper surface and increase lift. *Niña*, representing one of the greatest breakthroughs in yacht design ever, was still winning races more than 35 years after she was launched in 1928. Burgess also drew on his aviation experience to develop such new equipment as an improved system of securing masts upright. And in the 1930s he designed three highly sophisticated and successful America's Cup defenders, each reflecting an aviator's passion for strong, lightweight construction and aerodynamically clean shapes.

Leonard Greene was another important innovator in both yachting and aviation. In 1943 he proposed a landmark theory to show how aircraft could break the sound barrier, and his company in White Plains, New York, designs and manufactures airplane and marine instruments, including sensors that monitor the flow of both air and water. In the mid-1980s he developed what proved to be a controversial keel for *Courageous*, the 1974 and 1977 Cup defender. And in an especially important contribution to sailing technology, several years ago he matched his sensors to computers that displayed steering cues, thereby giving crews a greater sensitivity to their boats' performance.

For the 1983 Cup competition, Greene trained *Courageous'* crew us-

Enrico Ferorelli/DOT

The forces of wind, sails, and keel are in balance, although a tacking Stars and Stripes *is well heeled.*

the sailboat's keel works in water the way an airplane's wing works in air

Keels at Work

If sailboats had no keels, they would be limited to running before the wind, like balloons. They would be unable to maneuver across the wind or toward it because most of the force produced as the wind hits the sails would move them sideward. The boat's keel converts that sideward force into forward motion in much the same way that a glider, powered by gravity, uses its wings to convert the act of falling into forward flight. Interestingly, boat designers describe the work a keel does as "lift."

The better its keel, the less leeway (sideslippage) the boat will make. Better keels also concentrate more of the boat's weight underwater, where it can work to keep the sails perpendicular to the wind, counteracting the boat's natural tendency to "heel" and spill wind.

On *Australia II*, winglets at the tip gave the keel good lift. The winglets were made of lead, which lowered the center of gravity to below that of traditional designs, and helped prevent heeling.

Australia II's winged keel functioned like a much larger, deeper keel, but without the added friction that would slow the boat in light winds. The winglets' efficiency allowed designer Ben Lexcen to pare down the upper part of the keel where it attached to the hull, which also reduced friction.

In effect, the Australians got something for almost nothing.

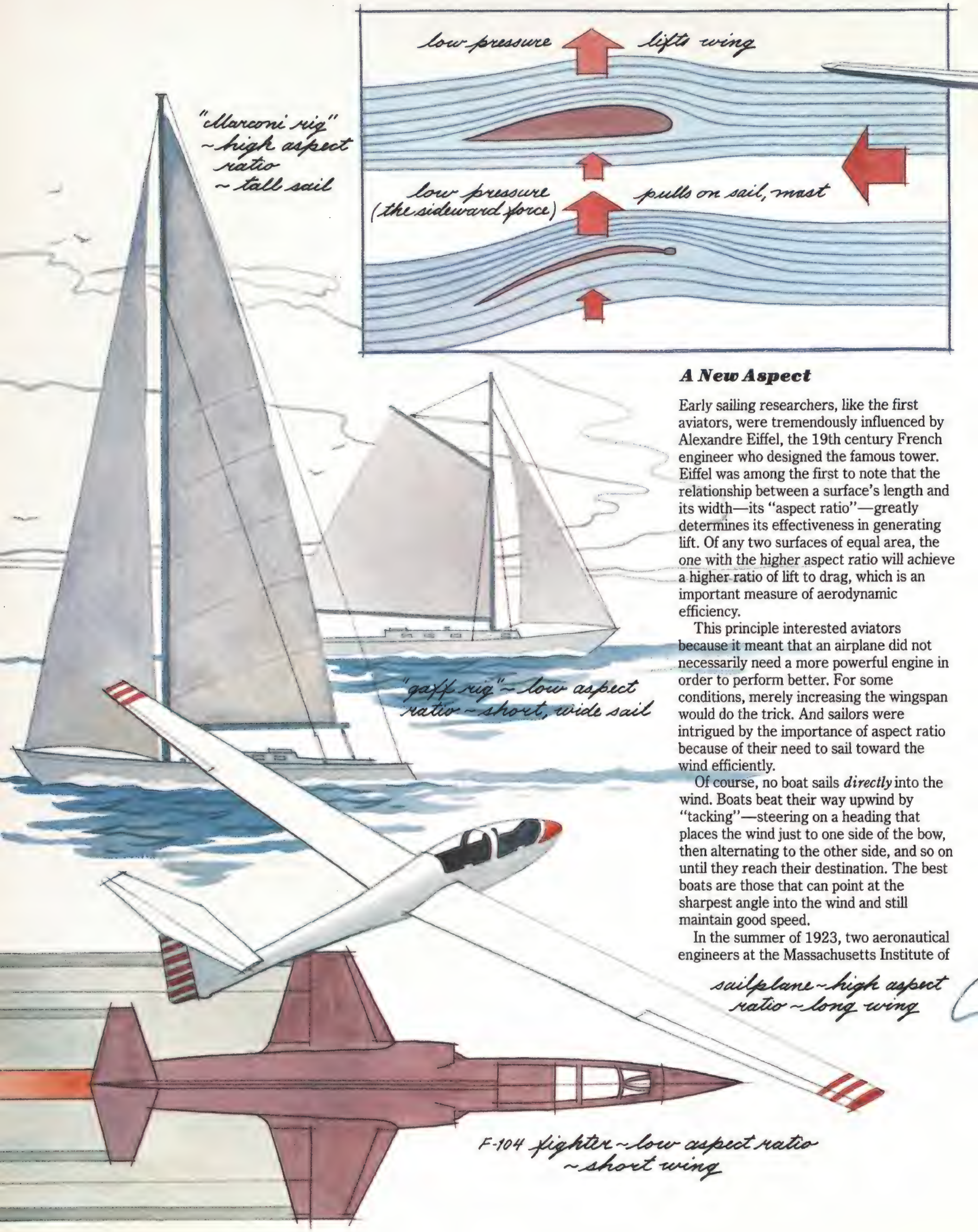
—John Rousmaniere

with its sails, a sailboat converts the wind's energy...

adding winglets makes a wing more effective

winglets make keels act "longer"

...into a sideward force ... and the keel resolves this sideward thrust into forward motion



A New Aspect

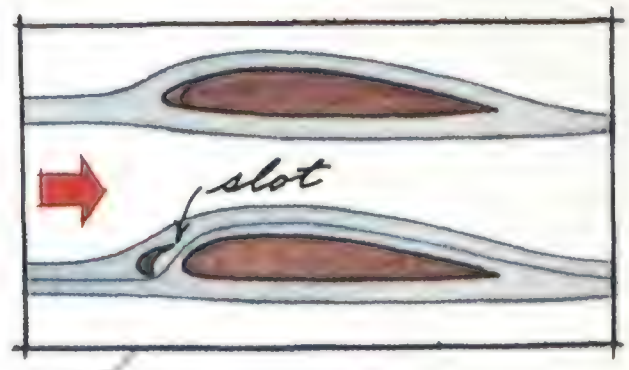
Early sailing researchers, like the first aviators, were tremendously influenced by Alexandre Eiffel, the 19th century French engineer who designed the famous tower. Eiffel was among the first to note that the relationship between a surface's length and its width—its "aspect ratio"—greatly determines its effectiveness in generating lift. Of any two surfaces of equal area, the one with the higher aspect ratio will achieve a higher ratio of lift to drag, which is an important measure of aerodynamic efficiency.

This principle interested aviators because it meant that an airplane did not necessarily need a more powerful engine in order to perform better. For some conditions, merely increasing the wingspan would do the trick. And sailors were intrigued by the importance of aspect ratio because of their need to sail toward the wind efficiently.

Of course, no boat sails *directly* into the wind. Boats beat their way upwind by "tacking"—steering on a heading that places the wind just to one side of the bow, then alternating to the other side, and so on until they reach their destination. The best boats are those that can point at the sharpest angle into the wind and still maintain good speed.

In the summer of 1923, two aeronautical engineers at the Massachusetts Institute of

DC-9 airliner: slotted leading edge deploys at low speed, enhances lift



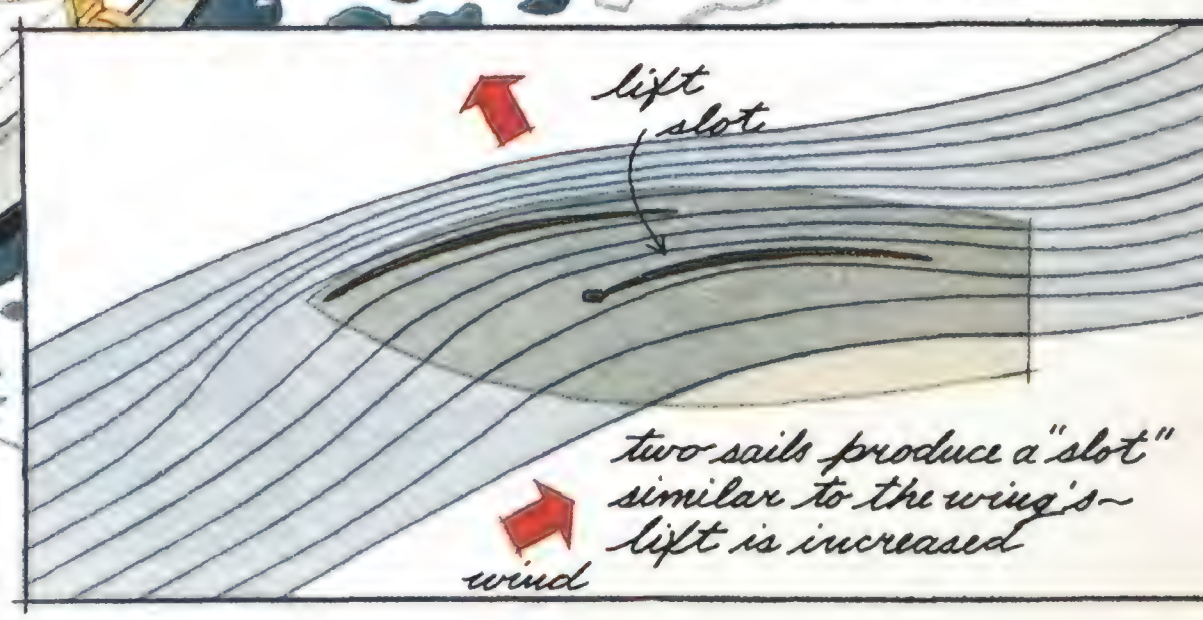
Technology, Edward P. Warner and Shatswell Ober, conducted wind tunnel experiments on a racing sailboat called *Papoose*. They concluded that a sail works much like a wing: the leeward (downwind) side of the sail, like the upper surface of a wing, provides most of the working force. In a sense, the boat is pulled more than pushed. They also discovered that the mainsail and its adjacent jib work together like the parts of a slotted airplane wing. The jib, they wrote, "serves to guide the air" onto the mainsail "and prevents breaking down of the flow."

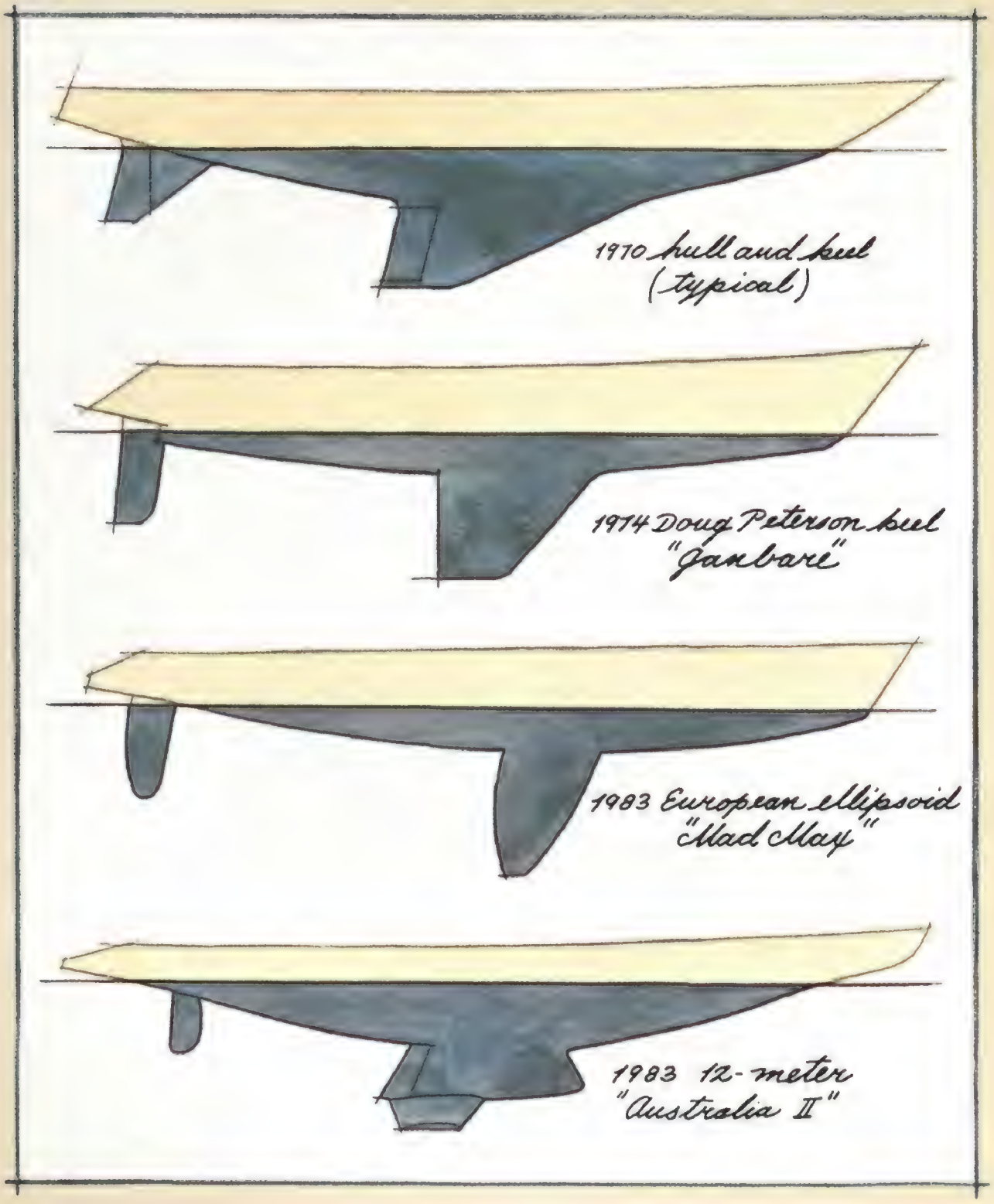
Warner and Ober also confirmed that Eiffel's insights about aspect ratio applied to sails. Before any of this research was done, almost all large sailboats had low, squat sails with aspect ratios of about 1:1, meaning they were about as tall as they were wide. But the new research drove yacht designers to look for a sail with a high aspect ratio. They eventually settled on a triangular mainsail, which came to be called the Marconi rig because its great height reminded people of Guglielmo Marconi's radio masts. The taller rig quickly proved to be superior, and by 1930 it was standard on most sailboats.

—John Rousmaniere

lift

wind





began drawing keels and rudders that way, using the airfoil shapes defined by the National Advisory Committee on Aeronautics, a research agency that became NASA in 1958. Keels with these thick foils were quickly found to provide good lift—or resistance to leeway—for upwind sailing, while the thinner versions produced less drag and were preferred for downwind sailing.

The profile shape of keels changed little until 1974, when Douglas Peterson, a young San Diego designer who was building a racing boat, asked an aerodynamicist friend for advice. Between his friend's recommendations and what he learned from *Fluid Dynamic Drag*, a book written by former airplane designer Sighard Hoerner, Peterson devised a keel with a more abrupt transition between the hull and keel than Stephens'. He named his boat *Ganbare*—"It's a Japanese word meaning the kind of good luck you wish a kamikaze pilot," according to Peterson—and she was the sensation of her day. Within months, the "Peterson profile" was appearing everywhere on boats designed according to the International Offshore Rule (IOR) for ocean racing, and it quickly became the standard keel design.

Hoerner's book also stated that if the amount of lift developed across a wing's span is plotted on a graph, it forms an ellipse that starts at zero at both wing tips and reaches its maximum at the wing's center. World War II British Spitfire fighters had wings shaped in elliptical curves that almost reflect the theory. In the early 1980s, some European yacht designers decided that any keel with an outline that exceeded the theoretical minimum elliptical shape had excess surface area, so they pared their keels down accordingly. Even Peterson began to use elliptical keels. As a result, the standard keel for many of today's racing yachts is shaped from a pair of gentle curves that are the spitting image of a Spitfire's wing.

But none of these innovations worked well in 12-meter yachts because the design formula that dictates the dimensions of these boats results in a boat heavy for its size. Much of that weight has no logical place to go but the keel. So besides all the inspiration from aerodynamics, designers can point to necessity for adding wings to the tips of their keels: wings put a lot of weight down low, where it can work harder against the force of the wind, which tends to heel the boat. Wings are never used in the form of winglets on IOR ocean-racing boats because the rules prohibit them. Besides, their keels are already shaped like wings.

—John Rousmaniere

Water Wings

Well before winged keels were even imagined, yacht designers and sail makers were influenced by developments in aviation theory and practice. Indeed, there had been several major shifts in boat design as builders consistently attempted to make the side view of their vessels' hull and keel look like an overhead view of half an airplane's fuselage and wing.

In the early years of yacht racing, the keel served one purpose—to contain the lead or iron ballast that kept the boat upright. Theories about its shape and size arose more from intuition than research.

In the early 1930s, naval architect Olin Stephens began to ask deeper questions about design. Theory and numerical analysis captured his attention while he was working with Kenneth Davidson of the Stevens Institute of Technology in Hoboken, New Jersey, who was conducting some early tank tests of boat models.

When Stephens visited Douglas Aircraft, he saw a mockup of the DC-3 that led him to begin exploring aerodynamics. Stephens noticed that there was a curved fairing with a tight radius that blended the leading edge of the wing into the fuselage and smoothed the airflow. "I used that principle in designing *Babe*," he remembers. "I put a tight radius at the leading edge of the keel where it meets the hull, and the boat was a consistent winner for a number of years."

Other designers soon followed Stephens' path to aerodynamics. When research in wind tunnels showed that the forward parts of wings should be thickest, designers

The Australians winged home with the America's Cup in 1983 after hosing the Yanks with this new keel.

Roger Garwood/Wheeler Pictures

ing what he delightedly calls "the aerospace approach to yachting." He set up radio navigation beacons around the race course to track *Courageous'* position within inches. The data were stored in a computer, and by studying the print-out after the day's sailing, the crew was able to evaluate the boat's every move. Greene took his latest *Courageous* to Australia for the current race, but he says he withdrew it when it proved uncompetitive against other boats backed by fatter treasuries.

Although one would expect to find the closest link between aeronautics and yachting in the design of sails, since sails and airplane wings do their work in the same medium, that hasn't been the case. "I've always had the view that wings and sails weren't that similar," says Owen Torrey, vice president and designer at Ulmer Kolius International, one of the world's largest sail makers. "The speeds and angles of attack are so different: a wing goes directly into the wind at more than 150 mph, while a sail moves at less than 10 mph at a variety of angles to the wind."

The sail maker's perpetual problem is figuring how to account for the ways that wind and wear will deform fabric sails so they no longer conform to the intended shape. Whereas an airplane's wing is rigid and performs consistently, the sails on most boats must be flexible; whenever a boat is stopped or when the sail area must be reduced in a strong wind, the sail must be capable of being lowered. And there must also be some way to change the shape of the sail when the boat is under way, either to give the sail a fuller curve for more lift in light wind or to flatten it when the wind increases.

However, soft sails have given way to wing-like hard sails in the highest-tech sailing there is: the C-Cat catamaran class. C-Cats are radically different sailboats that measure no more than 25 feet long and 14 feet wide, with no more than 300 square feet of sail area. Although the sails are rigid, the crew can adjust them so that they work equally well with the wind on either side of the boat. The 500-pound catamarans can average 14.5 knots (16 mph) around a race course.

Hard sails employ two aerodynamic characteristics that are stock in trade to designers of wings: camber, or the curve between the sail's leading edge and trailing edge, and aspect ratio, the height of the sail versus its width. The aspect ratio is fixed by the sail's dimensions, but the crew can adjust the amount of the hard sail's camber with controls. A boat sailing downwind, with the wind at a very high angle of attack, is like an airplane at low speed with its flaps fully down: it needs as much camber as possible. A lot of camber also produces a lot of drag, but in each case it's an acceptable trade for higher lift. When the boat turns to sail upwind, with the wind at a narrower angle of attack, the sail is flattened—the equivalent of the airplane with its flaps only halfway

Don Nerney/DOT

Ben Lexcen crouches over his 12-meter design, which was launched from a Dutch aerospace research lab.

Don Nerney/DOT

C-Cats Patient Lady VI *and* Victoria 150 *fly across the water borne by hard sails that work like wings.*

down—to reduce drag yet still maintain enough lift.

Roughly every two years these boats compete for the International Catamaran Challenge Cup Trophy, sometimes called "the Little America's Cup." Where the 12-meter rules severely limit the shape and weight of the mast that supports the sails—even to the point of specifying the location of the center of gravity—the Challenge Cup rules impose no such restrictions. Thus, C-Cat designers like David Hubbard of Stamford, Connecticut, have melded mast and sail into extremely sophisticated airfoils that 12-meter racers would drool over.

Hubbard, a mechanical engineer, had no direct help from the aviation industry. Yet his 35- to 40-foot-tall slotted wings are about twice as effective as the equivalent sails on a traditional sailboat. His sail designs have been adopted for Tony DiMauro's series of *Patient Lady* catamarans, which won consistently in Cup competitions between 1977 and 1982 against Australian and Italian challengers.

One constant that guides designers of all racing boats is the shape of the course. For C-Cats, the course influ-

ences the sails' aspect ratio. Although high-aspect-ratio sails that are tall and thin produce less drag than low-aspect-ratio sails, there's a limit to how far a designer can go. Hubbard points out that high aspect ratio increases the heeling angle because there's more sail area up high. In a strong wind it can tip the boat too far. "We're constantly juggling the shapes and aspect ratio," Hubbard says. "A high-aspect-ratio sail with simple flaps for changing camber is extremely good upwind, but a low-aspect-ratio sail with many flaps is better downwind. You have to choose."

The Challenge Cup is usually sailed in light to moderate winds, and while the course has five upwind legs, it also includes lengthy runs downwind. In the 1985 match, Hubbard chose to emphasize upwind sailing. "In 1982 the Italians had scared us with a boat that was good upwind," Hubbard says. "So I worked on upwind speed. Being in the lead, you don't look for radically different things to do, so we were cautious."

When the Australian challenger *Victoria 150* turned up for the Cup race, Hubbard realized—too late—that he had been on the wrong track. The boat's designer, Lindsay Cunningham, developed a dual-slotted wing based on his own wind tunnel research, and it had an aspect ratio lower than *Patient Lady*'s wing. An elaborate system of flaps allowed the Australian crew to adjust the wing's camber with authority and accuracy. Described by Knowles L. Pittman of *Sail* magazine as looking from a distance like "a sturdy, broad-shouldered lighthouse," the new wing was as much a breakthrough as the winged keel had been in Newport two years earlier.

When the races began, a clear pattern quickly developed: *Patient Lady VI* gained 10 to 20 seconds on each upwind leg, while *Victoria 150* gained 40 to 50 seconds on each downwind leg and won going away. Hubbard's disappointment was profound. "Only because Cunningham did wind tunnel work did he find this out," Hubbard recently commented. "In one fell swoop he changed the whole ball game."

Once again, a trophy was lost to the most radical innovator, once again the workshop door was opened wide to revolutionary development, and once again the wing held sway.

Owls Head Transportation Museum

A Sailplane at the Interface

At the Ancient Interface, a sailboat enjoys a fascinating interplay of air and water, being blown by the first across the surface of the second. But don't expect a single fluid to act upon itself to produce motion: air can't propel an airplane through the sky any more than water can propel a boat over the ocean.

Unless you're another John Domenjoz, a man who designed and built what was intended to be a sailing glider.

The curious craft currently resides at the Museum of Transportation in Owls Head, Maine. It is beautifully made, with a handsome wing and light yet sturdy braces supporting the tail section. And behind the pilot rises a short mast . . . and from the mast, two sails. No kidding.

It's a perfectly good glider and slips along nicely above Rockland Airport during the museum's summertime flying shows. But if you think the sails do anything but flap in the breeze, you're just as confused as the inventor.

Born in Switzerland, Domenjoz worked with the great French aviator Louis Blériot, learned to fly at the Blériot Flying School, and earned Belgian flying license number 33. He put on acrobatic shows in Europe and North America, and in 1915 came to Long Island to fly out of Sheepshead Bay Racetrack. He was a huge hit, wringing out his sturdy little Blériot monoplane once a week to enthusiastic crowds as far away as Manhattan. They say he once did 40 loops in 28 minutes.

Domenjoz returned to Europe during World War I, then rebounded to the States as an instructor and barnstormer. He was working as an inspector for Pratt & Whitney in 1929 when he built his strange sailing glider and took it to Maine's Old Orchard Beach to try it out. Curators at the Transportation Museum think he made about 50 flights, towed aloft behind an automobile but certainly not under the power of sail.

Domenjoz died in Connecticut in 1952, leaving no survivors—only the glider. So the question remains: Did this man who should have known better so misunderstand the forces of nature that he seriously thought his contraption would propel itself? Or was there more to it?

The man had tasted glory, but then aviation moved ahead of him, leaving him offstage. He must have yearned to get back into the picture. Domenjoz may also have known of the Boland brothers' tail-less biplane, which used two sails between the wing tips to bank and turn. Perhaps he figured that the sails helped propel the Boland craft as well as control its turns.

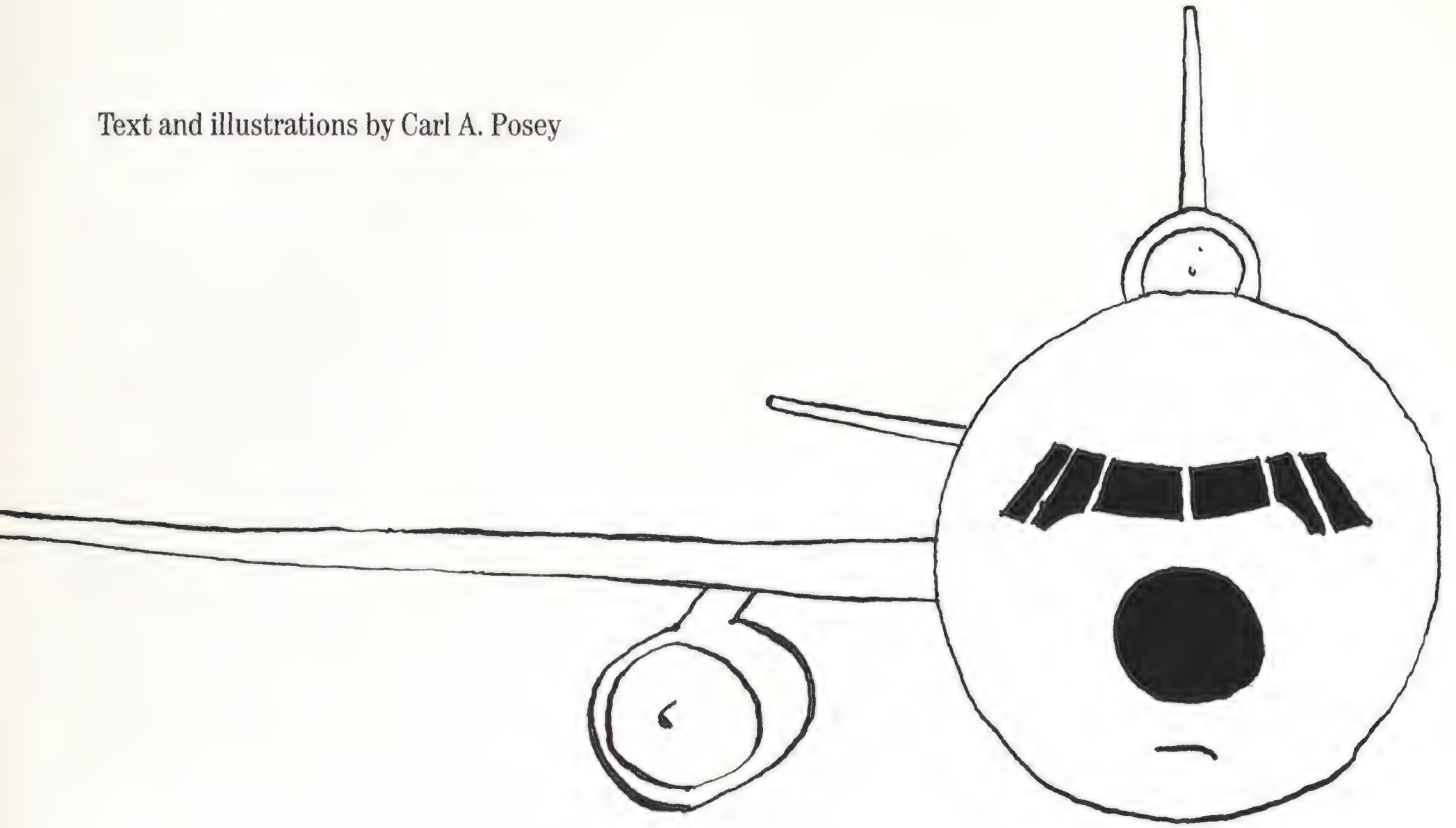
Anyway, Domenjoz's glider was the kind of gimmick the press loved, and it didn't cost much. For a moment, he basked in a small flash of limelight. I don't believe that he was the slightest bit confused about fluids. I think his weird glider simply gave him a quiet chuckle while he posed for the cameras.

—Edwards Park

Text and illustrations by Carl A. Posey

An airplane's personality is as plain as the face on its nose.

The Boeing 757: a level gaze and intelligent brow set it apart from its gouty larger sibling, the 767.



Just spend a few minutes on an airport observation deck watching the comings and goings and you'll see that an airport is a veritable portrait gallery. The soul of an airplane—its internal tensions and conflicts, lifestyle and world view—can be read in the expression stamped on its aluminum face by a cohort of aeronautical engineers. And sometimes, it seems, those technical whizzes don't realize that it is foolhardy to ignore how an aircraft *looks.*

All airplanes have faces, of course. That's why we sometimes paint white fangs on them, and eyes of the type that once graced the bows of galleys. But some are more revealing than others. The sharp, reptilian faces of military aircraft tell us about as much as the proverbial crocodile's smile (except for Lockheed's jolly C-130 Hercules transport), and often they are too young to possess enough personality to reveal. Light aircraft, on the other hand, are too open, like the shining faces on large-toothed 11-year-old boys. But airliners bare their hearts—how they feel about themselves, their work, the world around them—in their faces.

A Boeing 757, for example, has the proper look for cracking multibillion-dollar markets. The windscreen presents a level, steady gaze beneath an aluminum brow that evokes dolphinesque intelligence in the long, rising curve of the forward fuselage. Shrewdness, serenity, and sagacity shine through, the very qualities that permit airplanes to cope with all the human, mechanical, and natural forces that conspire against flight. There is not a trace of a frown, nor the slightest hint of nervousness or bile. On the other hand, the 757's gouty larger sibling, the 767, does not show much of anything in its face. Searching its vacant gaze for the face of the smaller airplane is as futile as searching the face of a middle-aged man for the vanished child.

The McDonnell Douglas DC-10, however, is another matter. Above the black, bulbous nose of the radome, the windscreen droops in a myopic squint, a metal frown. At first glance it seems sneeringly pugnacious, perhaps a useful quality when a large airplane must intimidate lesser craft in its way. That

FaceValue

may have been the intention of its creator. Certainly the aircraft has admirable qualities and is probably grand fun to fly. And yet, its woeful countenance suggests that this is an unhappy airplane.

How did this fine flying giant come to wear such a bad-tempered expression? It conjures up an odd, driven, melancholy engineer in Lakewood, California, drawing the fatal line that drained all hope from the eyes of the DC-10. The engineer must have surfaced only briefly, then vanished or reformed, for no other airplane carries such a dismal stamp.

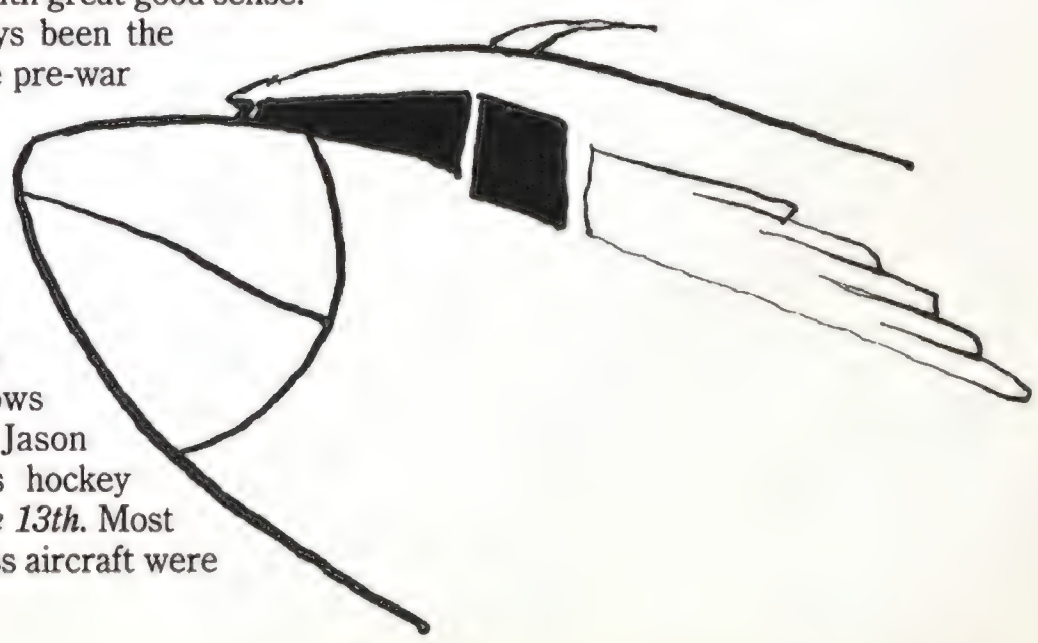
Look at other airplane faces. Not one of them appears sad, let alone depressed, worried, or forlorn. And nowhere else in the distinguished Douglas series is there a cheerless face. Nothing has ever looked cannier than the DC-1, DC-2, and DC-3, with the slightly freakish, superior carriage of the head seen in certain finches. But here the impression is amplified, as if these big metal finches spoke seven languages. The next four aircraft in the series radiate assurance and increasing zeal: the somnolent but goodhearted expression of the DC-4 becomes sharper and a bit harder about the mouth in the DC-6, more business-like in the DC-7, and undergoes an evolutionary sleekening that gives rise to the slightly snake-faced DC-8, with its narrow head and hollows beneath the nose.

The DC-9 and its quiet, stretched descendants share a stalwart look, probably borrowed from Walt Disney characters: they lack only soft, floppy ears. On difficult instrument approaches, a DC-9 must knit its brow and poke out a small rim of a tongue from a duct beneath the nose radome.

On the ubiquitous Boeing 727, one finds a face splendid with a kind of canine spirit of cooperation, a Labradorian eagerness paired with great good sense. This has not always been the case at Boeing: the pre-war Stratoliner really had no face at all, and the post-war Stratocruiser seemed to hide behind those little rectangular windows in the nose like Jason lurking behind his hockey mask in *Friday the 13th.* Most likely, these faceless aircraft were

The DC-10: with one stroke of an engineer's pencil, its woeful countenance could become a face that radiates the joy of flight (above).

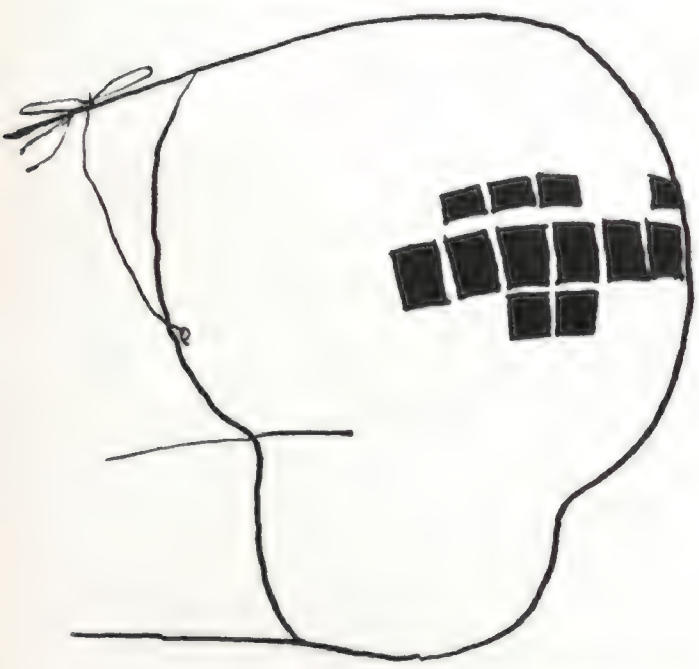
The DC-3: the canniest of airplanes, with the superior carriage of the head seen in certain finches.



merely the final designs of vanishing Piston Man, for Boeing faced the jet age commendably.

Foreign aircraft mingle with familiar American airplanes at larger airports, and while no morale problem is evident, one detects a faint sheen of duplicity. The Soviet Union's Tupolev Tu-104 reveals almost nothing, even when looked square in the eye, not wanting to expose its elaborate masquerade as a bomber in commercial transport clothing. Its drag chute protrudes from beneath its costume like a cat's tail twitching in the bushes. The Tu-104 taxis about with eyes on the sky, all innocence, sometimes whistling to show that its mouth isn't dry.

The Constellation: a look of delighted surprise.



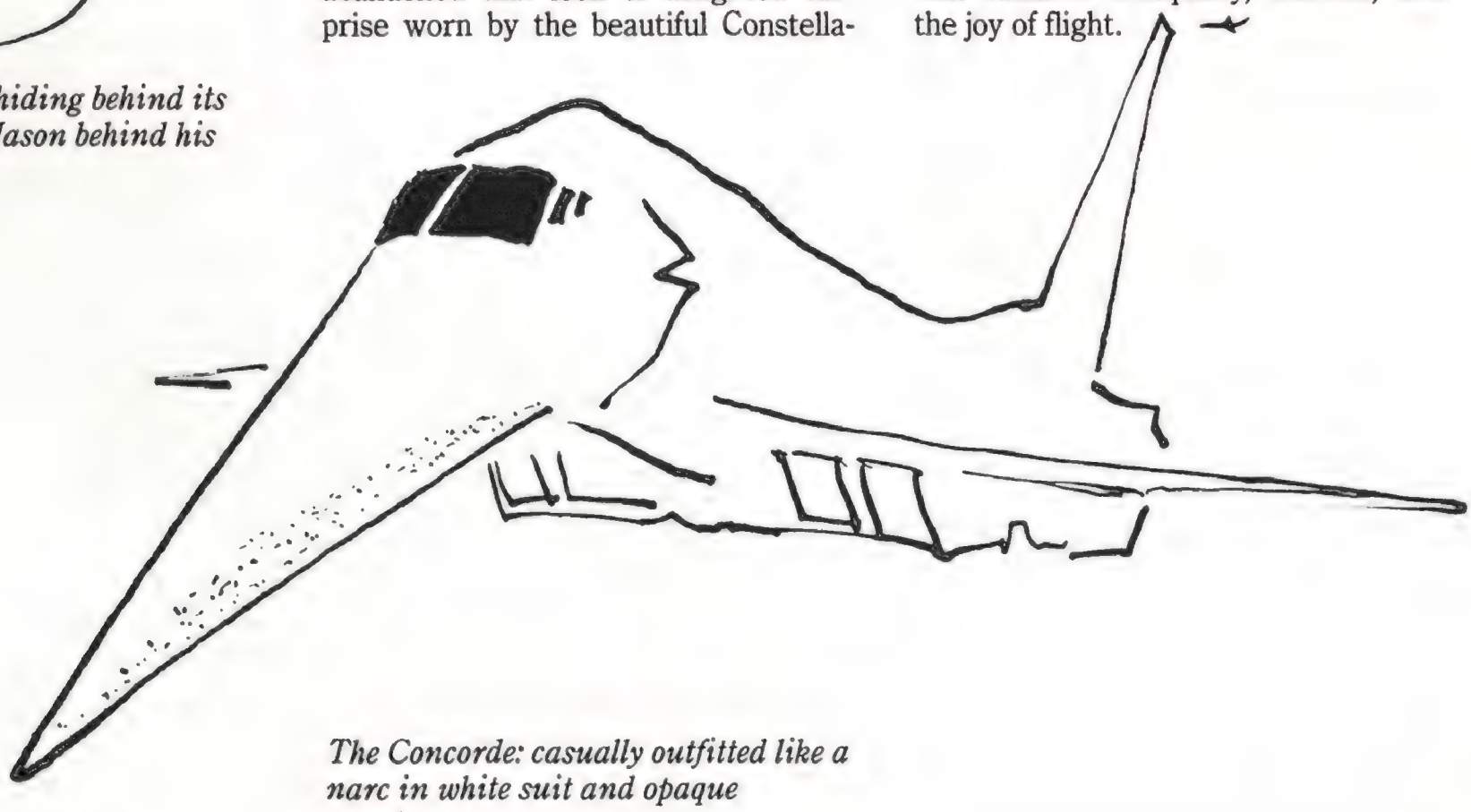
The Stratocruiser: hiding behind its little windows like Jason behind his hockey mask.

The newly arrived British Aerospace BAe 146 is a puzzlement. Its face is that of a bad boy at Eton, aristocratic and perhaps a bit cruel, joined to a stubby working-class body that belongs in a mill. Clearly, good blood flowed through the family at some time, but it has been too diluted in technology's melting pot.

Among the giants—one wants to say the adults, so youthful are the smaller transports—we find Airbus Industrie's A300, frankly cynical and a little naked without a Gaulois cigarette stuck in the corner of its ironic visage. Even the somewhat sinister Concorde, casually outfitted like a narc in a white suit and opaque sunglasses, shows no decline in spirits. Lockheed's L-1011 tri-motor transport reassures with a strong aura of sincerity, while inviting flight with a bird-like profile, eagle-eyed and alert. (What a shame that Lockheed engineers abandoned that look of delighted surprise worn by the beautiful Constellations.) And the Boeing 747—well, it seems to be the happiest and most intelligent of all airplanes, with its fine, aquiline nose and knowing, sleepy eyes.

No, only the DC-10, alone among its peers, wears an expression of despair. But suppose the present windscreen were replaced by one that formed a slightly upswept "A" instead of that shallow, frowning "V"? Why, the aircraft would be transformed into an eager-to-please, contented giant, its sulking demeanor relegated to scrapbook photos of an awkward adolescence.

Let us hope that the engineer who so burdened the DC-10 has left the field forever. Let us also hope that at this very instant, a young man or woman is taking an eraser to a frowning face peering from the blueprint of an airplane just aborning, and with one stroke of a pencil transforming it into a face that radiates tranquility, wisdom, and the joy of flight.



The Concorde: casually outfitted like a narc in white suit and opaque sunglasses.

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NORTHROP

Space Coast denizens are trying to ride out the rough times that have followed the *Challenger* accident.

All Quiet on the Launch Pad

by Fred Reed

Photographs by Medford Taylor

Time and again, all along Florida's Space Coast, from engineers and waitresses and business people, in offices and restaurants from Cocoa Beach to Melbourne, one hears the same prescription: "We ought to launch again now. Put three astronauts in a shuttle and go. When you fall off a horse, you get back on."

Among residents of this region, which enfolds the National Aeronautics and Space Administration's Kennedy Space Center, there is no lack of feeling for the astronauts who perished in the *Challenger* explosion last year. They were, after all, a part of the community. Still, there is a belief that the space program is more important than a few lives, that risks are part of this business, and that the astronauts knew it and chose to take the risks. "Everybody knows flying is dangerous," the thinking goes. "The astronauts knew. You can't stop the program because of one accident."

Hugh Brown, president of BAMSI Inc., a Titusville technical services company with jobs at Air Force and NASA installations, puts it succinctly: "Boeing doesn't stop flying airplanes because one 747 crashes."

In a sense it was not just *Challenger* that crashed, but the whole space program, a way of life, a sense of purpose. A year has passed since the explosion, yet the ghastly flash in the sky still hovers over Cape Canaveral. One hears of it constantly in the after-hours haunts of Cape workers. Try Mugs, a favorite of aerospace technicians that sits off an isolated country road slicing through the ragged foliage of Merritt Island.

The interior of Mugs is rural honky-tonk, dark, not fancy, with pool balls clicking in the back and a guitar-playing singer sometimes belting out bluegrass. For a region engaged in the launching of spaceships, the Space Coast is surprisingly rural, resembling small-town Alabama much more than high-tech, high-rise Los Angeles. Mugs could be any hash house by any road in the South, except for the conversation: "Triple redundancy" . . . "KU band docking radar" . . . "LOX bleed valves." And the explosion.

At the bar, an engineer laid off after the accident tells a common story: "We want to stay here. We're trying to make up our minds whether to buy a house. We could do it from savings and live on my wife's salary, but when am I going to work again? They say there'll be a launch in '88, but that could slip. We're not sure how long we can wait."

Many are waiting, wondering what they can do and what NASA will do. When *Challenger* blew up, close to 16,000 people were working at Kennedy Space Center, including 6,700 on the payroll of Lockheed Space Operations Company (LSOC, inevitably pronounced El Sock), the area's largest employer. With a team of subcontractors, LSOC manages what NASA refers to as "ground processing"—shuttle preparations, for example—for what was supposed to be, but never quite became, a spaceport. After the explosion LSOC

Wildlife basks in the Space Coast's newfound peace. Residents find the lull unnerving.

The "rocket garden" now draws more than two million visitors a year to Kennedy Space Center. They stream in even while NASA sorts out the space program's future.

quickly cut its ranks by 10 percent. As NASA's start-up launch date moved to early 1988 at best, more employees were laid off. People grew accustomed to waiting for the other shoe to drop.

Counting precisely how many have lost their jobs because of the explosion is difficult: some would have been laid off anyway because they had finished their projects, some took early retirement, others accepted jobs elsewhere. Officials at the Cape estimate that 2,200 people were let go one way or another because of the accident.

By late 1986 relief came into view: according to Kennedy spokesman George Diller, "It appears that we'll have to hire back all the people we laid off" starting this fall, when the center will begin final preparations of the shuttle *Discovery* for launching. But in spite of this promising development, some people still believe the space program is in trouble.

It's not just individuals who are worried. Space businesses are growing nervous, too. As Hugh Brown says, "Right now the problem is more psychological than economic. That could change, of course. The worrisome thing is uncertainty—not knowing what to do next waiting for NASA to decide."

Despite the questions, the *Challenger* accident has not been a catastrophe for the local economy. John Wil-

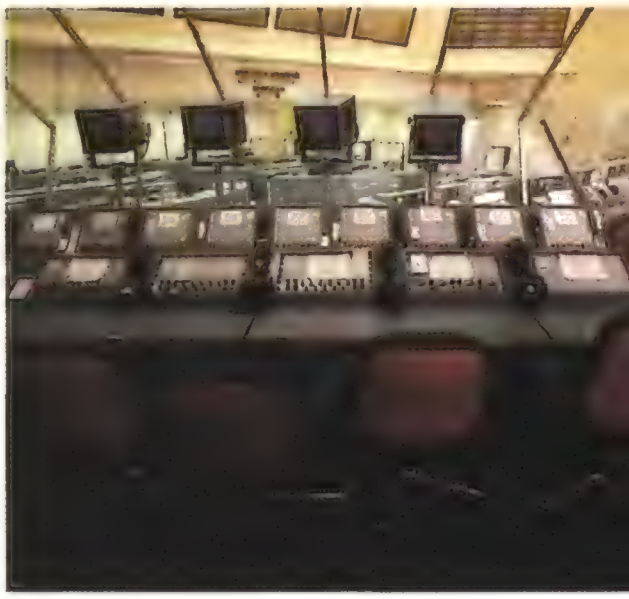
Atlantis, *here sheltered by the mobile service tower, moonlighted for launch tests last fall.*

liams, LSOC's director of public affairs, explains: "In recent years the area has developed a diversified economy. Kennedy isn't the only employer now." Harris Corporation, for example, a Melbourne information technology company that is the region's largest corporate employer, has many other customers besides NASA. "If you look at the actual numbers laid off, compared to total employment, it isn't that bad," Williams says. "And we've managed to find other jobs, here or elsewhere, for a lot of our people. But if you are one of the ones laid off, then it's bad." Lockheed and some of the other firms have also tried to find work for their employees.

Rodney Ketcham, president of a Cocoa Beach real estate company, offers an estimate of the economic fallout: "I don't have hard figures, but I'd say that the motel and restaurant trade is off by 20 to 30 percent. We used to have a lot of people come through for launches, mostly contractor personnel. That's gone. There is no avalanche of homes on the market yet, but used-car listings are up. People are trying to ride it out, cut expenses, and maybe live on a spouse's income."

Against a background of moderate recession for the community as a whole stand bad times for the few. The disaster has certainly depressed housing prices. A real estate contractor reports, "The ones who are really getting hurt are people who for one reason or another have to move. They can't get what they put into their houses. Prices will come back up when things get going again, but some people who were laid off have to move now."

If the economic damage is tolerable, the morale damage is harder to live with. People here believe in the space program, believe the United States needs the shuttle, needs to be foremost in space. If financial troubles were to magically disappear, gloom would remain. "The worst thing is that we're going to lose our good people if we aren't careful," an engineer observes, his wife nodding in agreement. Almost everyone says the same thing. "I'm not sure the country understands this," he continues. "People here do things that just aren't done elsewhere, because



Takeoff simulations, which help keep launch teams sharp, occasionally break the stillness of the control center in Firing Room 1.

they don't launch shuttles anywhere else. A lot of knowledge is involved, a lot of experience, and a lot of it isn't written down. If you let these people drift away, hey, they're gone. They won't come back. And it takes a lot of time and mistakes to learn again."

One reason why laid-off personnel might not return is weariness with the space program's boom-and-bust nature. Critics say that the United States has not made a consistent, continuous commitment to advancing into space. Instead, it has tackled a series of projects more or less one by one, with no assurance of what, if anything, will come next. People do not work for the space program. They work for a particular project and are laid off when it's over.

Layoffs at the end of the Apollo program are cited to place post-*Challenger* layoffs in perspective—Apollo layoffs didn't end the space program; the latest round won't end it either. But now there are doubts about the shuttle, about whether it will ever get up to speed again. People here see the signs from Washington as confusing at best, dis-

Armed with new information gleaned from the Challenger *accident, workers prepare* Discovery *for a launch in 1988. The first shuttle mission since January 1986 will deliver a tracking and data relay satellite into orbit.*


Orlando
Cocoa Beach
Cape Canaveral
Chevron
WEST
EAST
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TO
95

A sense of history runs deep in the Cocoa community, which patriotically decked out its landmark water tower for the Bicentennial (left).

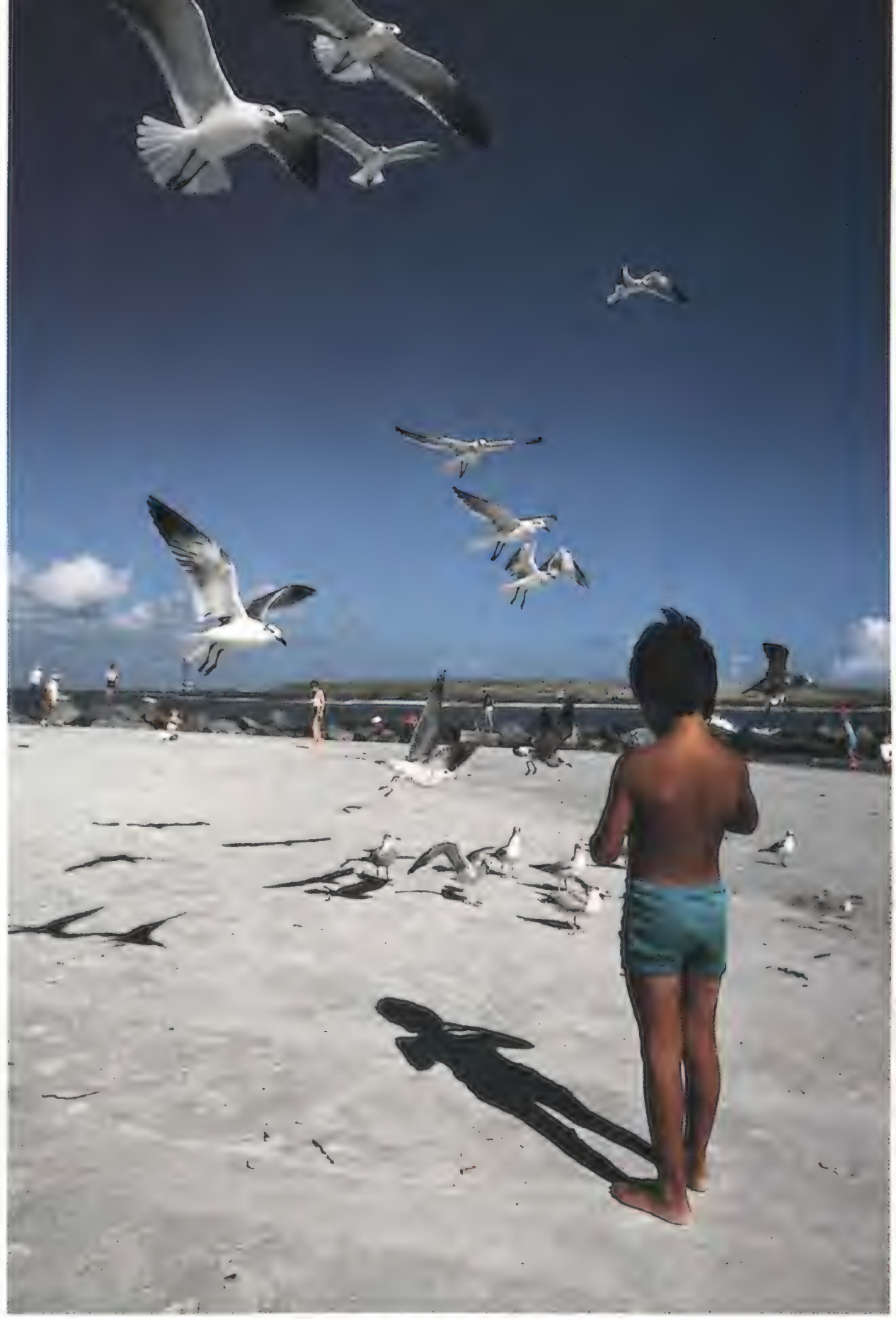
The best public perch for viewing launches is Jetty Park at Port Canaveral, across the Banana River from Kennedy Space Center (right).

couraging at worst. A new shuttle launch site at Vandenberg Air Force Base in California, built to launch payloads into polar orbits, is being mothballed until 1992. Congress has approved funds for a new shuttle to replace *Challenger*, but at the same time President Reagan has directed NASA to stop hitching commercial payloads to the shuttle, easing pressures to step up launch rates and ending all pretense that the shuttle can pay for itself. But there is no ground swell of public support for a next-generation shuttle fleet, and the fate of NASA's $8 billion space station project, in these days of budgetary belt tightening, is uncertain.

Again and again, the same message comes through—a space program is a complex effort and a long haul. You can't stop it and start it, change your mind in the middle. People seem bothered by the lack of national direction. The unspoken premise, a matter of unquestioned faith in these parts, is that the shuttle should be part of the future.

One comes to sense that people here are somewhat out of tune with the rest of the country, that they are filled with the enthusiasms of 20 years ago, when Americans were on their way to the moon. These days most of the country seems bored with space. But here the flame still burns. A technician for Lockheed, asked about any drawbacks to working at Kennedy, says, "There are no bad points. I've been with the shuttle for seven years, and it has all been upswing. . . . Well, there's no overtime now, that's the only problem."

He adds, as if puzzled how anyone might not see it, "You're part of history. Where else can you get that?" Those who work in the space program share a fierce conviction that we need the shuttle, more shuttles, a next-generation shuttle. The technician, perhaps whistling a bit in the dark, asserts without



Bartender Mary Ann Fernsler offers an ear and a beer to regulars at Mugs.

hesitation, "There will definitely be a second-generation shuttle. . . . There is no replacement for people in space. Machines can do a lot, but for some things you have to have humans." Others familiar with the space program have expressed doubts about these things, but no one here wants to hear them.

Perhaps such conviction begins to explain why residents of the Space Coast were taken aback by the glare of publicity following the accident. They are unhappy about what they see as unfair treatment by the press. People here are used to praise, to being the good guys. For years the national media have contrasted NASA's relentless successes with the failures of other agencies. The Space Coast was the shore of the solar system, where dedicated people of pure motive were paving the way into the next century.

Following the *Challenger* explosion came unwonted criticism. Revelation followed revelation of sloppy work, defects concealed from the astronauts, attempts to blow the whistle that were ignored in the interest of expediency. Whatever the truth, the shock was profound. Says a Lockheed worker, "What makes me mad is these guys saying we're a bunch of stumblebums, like we didn't care what happened. What do they know? I knew those astronauts. I mean, we played practical jokes on each other. I'm gonna send them up in a broke ship?"

This more than anything else—the thought that people just didn't care what happened to the astronauts—outrages space center employees. Steve Scott, manager of Mugs, says, "I saw grown men cry while watching the *Challenger* disaster on TV. Most felt they lost part of their family. We all still choke up when it's mentioned. . . ." When it is pointed out that, one way or another, a "broke ship" was indeed sent up, the usual response is, "Well, I did my job, and the guys in my shop did theirs, and I don't know anybody who would take a chance with the lives of the astronauts."

The people in this region feel they've been intruded upon. As in most small-town areas, residents are used to a regional privacy, occasionally showing up on national television but mostly leading quiet lives, doing their work and being pretty much left alone. They are an open and friendly lot, this being the South and engineers being engineers, although their professional lives are closed to anyone who doesn't know how to speak space ("demodulator" . . . "hypergolics" . . . "redundant channels"). Last winter they suddenly found their privacy violated by a press that, for the first time in memory, was asking hard questions. The Space Coast didn't know how to handle it.

Or is it? "The worrisome thing is uncertainty—not knowing what to do next, waiting for NASA to decide," says a Space Coast inhabitant.

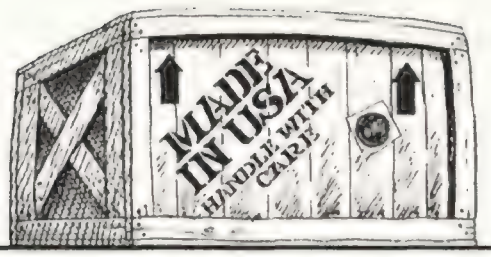
Most residents believe that the publicity and distress were excessive, though they express this idea carefully; no one wants to seem callous. Yet some will point out that if the astronauts had been killed in a car crash, nobody would have been so upset. "We can't stop the space program for this," they'll say. "Really, why is everybody so surprised? The astronauts knew the shuttle was dangerous. Sooner or later one would blow up. Pilots understand this. They flew because they wanted to. The trouble is, NASA sold the shuttle as a kind of bus: you know, safe—you ride across town, you know you'll get there. Now the whole thing comes to a stop for who knows how long because of one crash. It doesn't make sense."

The hard sell stems at least partly from NASA's having to compete for funding with countless agencies and interests. Each casts its projects before Congress in the best possible light, often a rather rosy one. NASA indeed sold the shuttle as utilitarian, yet no one at the Cape seems to think of it as anything more than an experimental system. But having promoted the shuttle as a bus, NASA came under pressure to make it perform like one. Many engineers here seem to understand this political reality, though some do not. Technical people, by nature practical and accustomed to making things work, are not always comfortable with politics.

Hugh Brown concisely expresses the majority opinion: "The program should not have been brought to a halt. Congress for political reasons gave the *Challenger* accident excessive scrutiny, overstudying it, not getting on with things." "Political reasons" is a common phrase, invariably used with disapproval. Another Space Coaster elaborates: "We've got government by publicity, and it doesn't work."

At heart, though, Space Coasters remain an upbeat lot. "Things will get better," says real estate executive Rodney Ketcham. "We just have to wait for Congress to decide what to do." Technicians keep busy updating equipment, getting ready for the resumption of flights. The *Discovery* is undergoing modifications for a February 1988 launch, while *Atlantis* and *Columbia* are in storage, waiting their turn. Kennedy Space Center has a handful of expendable launchers to send off this year, too. The space center is a big operation, and there is always plenty to do.

One subject that does not come up is what might happen if another shuttle explodes, or if a crew is stranded in orbit. When asked, people say that the program would push on. Sometimes the dark thought arises that Congress might someday shut down the manned program and move to increasingly sophisticated unmanned vehicles. . . . No one wants to think about it. It's not a real threat, because a mixed fleet of manned and unmanned launchers is what Washington wants now. But events of the past year have made it hard for the people of Kennedy to feel sure of their role in rebuilding the space program. Their wounds will heal, they'll carry on—but the scars will endure.



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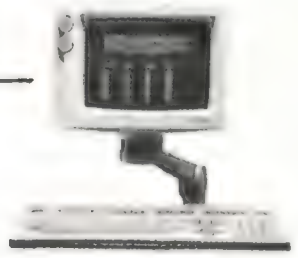

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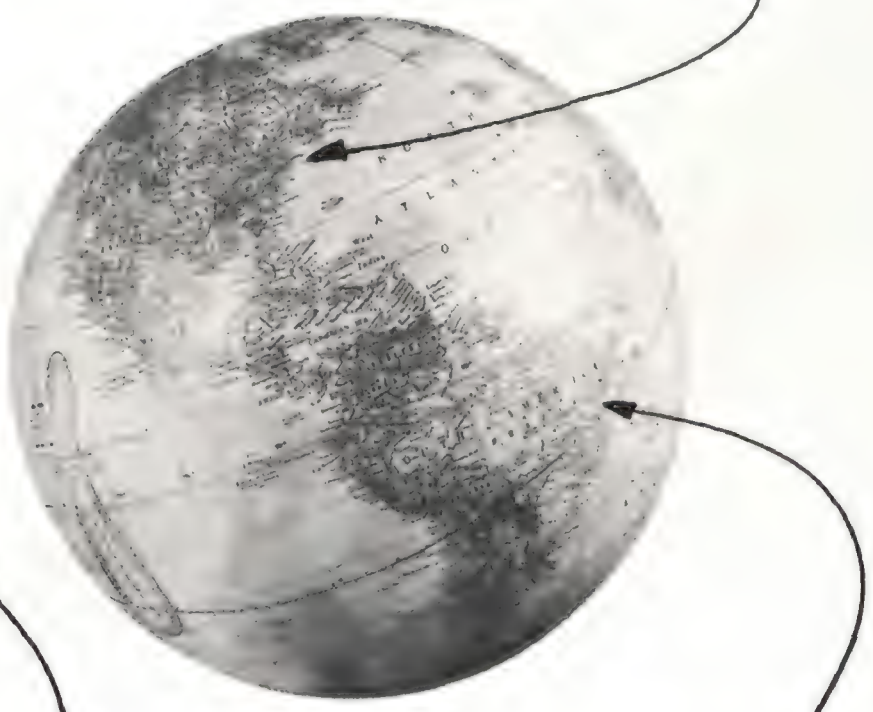

As a division of the Department of Commerce, the International Trade Administration's U.S. and Foreign Commercial Service helps American businesses stay competitive with overseas export markets. To do this, they needed a computer system that could collect, process, and analyze information from over 200 worldwide sources. A system that could integrate data processing, office automation and telecommunications. After a thorough search, the ITA focused their attention on Wang, who established a Worldwide Communications Network the ITA isn't about to trade.

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CAPTAIN CHARLES NUNGESSER

Lost: one biplane, two French national heroes.

THE SEARCH FOR L'OISEAU BLANC

by Stephan Wilkinson

Illustrations by Alan E. Cober

The mystery began on May 8, 1927. It will end, it is hoped, sometime before May 8, 1987—60 years to prove how, why, and where two brave French pilots disappeared, as Charles Lindbergh said, "like midnight ghosts." Then, finally, Charles Nungesser and François Coli will be awarded their proper footnote in history. It will read something like: "Although Lindbergh has long been credited with making the first nonstop transatlantic air crossing between the United States and Europe, in early 1987 it was proven that he was in fact only the third person to have done so. Twelve days before Lindbergh . . . " But wait—let's start at the beginning.

The leading men. Charles Nungesser was a lover and a fighter, automobile racer and World War I ace, drinker, dandy, and air show pilot. But in 1927 he needed a new gig. The Chuck Yeager of ragtime France, Nungesser made great copy for reporters, but he had bills to pay and a failed marriage, and his 30s were marching swiftly by.

His partner, François Coli, had an odd sense of humor, perhaps because he saw life through only one eye, having lost the other during the war when he hit the roof of a hangar while landing after a mission. (Before being carted off to a hospital, squadron leader Coli paused to proclaim, "Henceforth it will be against regulations for anybody other than the commander to enter the hangar by means other than the door.") He also had the beak of a buzzard and a perpetual mysterious grin. Coli had already set several long-distance flying records, including the first nonstop trip across the Mediterranean and back. Although few people outside the aviation field had ever heard of him, Coli had a solid reputation as a navigator.

Nungesser had long wanted to be first to fly the Atlantic nonstop, and the standard account has it that he engaged Coli to sit quietly in the right seat and chart the way. (Nungesser

was no navigator. A stick-and-rudder man, he had shot down 45 enemy airplanes during the war, which cost him many broken bones, some of which had to be wired back together.) But behind the scenes, Coli may have provided the real mental horsepower for the flight. He had planned to make his own transatlantic attempt in a big Potez 25-0 biplane, along with a pilot named Paul Tarascon. But the Potez was destroyed and Tarascon badly burned during a test flight.

Most likely, the Nungesser-Coli pairing was a marriage of convenience arranged by aircraft manufacturer Pierre Levasseur. The draw for Levasseur was not only the fame of the $25,000 Orteig Prize, to be awarded for the first nonstop flight between New York and Paris, but also the fortune of a contract from the French government. Levasseur was promoting a new biplane, the PL-8, which had most of the lines and all of the grace of a flying breadbox. It also had a watertight belly and, although not intended to be a seaplane, could land on water after the pilot dropped the landing gear and activated a device to stop the propeller in a horizontal position.

NUNGESSER HAD LONG WANTED TO FLY THE ATLANTIC, BUT COLI MAY HAVE PROVIDED THE BRAINS BEHIND THE FLIGHT.

Levasseur felt this made the biplane ideal for the French navy: ocean patrols could be carried out in the PL-8 with an added margin of safety. What better proof than to have Nungesser and Coli cross the Atlantic in the airplane and land in New York Harbor at the foot of the Statue of Liberty?

So at 5:17 a.m. on May 8, 1927, Nungesser and Coli staggered aloft from Paris' Le Bourget airport in *L'Oiseau Blanc*, "The White Bird." On the side of its hospital-white fuselage, the airplane sported Nungesser's wartime insignia—a coffin, two candles, and a skull and crossbones inside a black heart. Just over 1,000 gallons of fuel filled *L'Oiseau Blanc*'s three man-high aluminum tanks, which were located behind the engine, in place of the usual pilot's cockpit. Swaddled in leather flying suits, Nungesser and Coli sat together in a widened, open rear cockpit originally intended for an observer, so far behind the engine that the propeller would have reached New York a tangible moment before they did.

Lightning flashed to the north as the heavily laden airplane slowly gained altitude. But the weather forecaster had predicted good weather over the North Atlantic, with a tail wind component and relatively fair skies. He was wrong.

As the airplane neared the French coast, Coli tugged a handle to release the wheels, which were no longer necessary and only increased drag. The landing gear, rubber tires attached to wooden struts, fell into a farmer's field like a ghostly cart. Today the gear, one tie rod bent and fractured, the tires crumbling, is a poignant exhibit in the Musée de l'Air at Le Bourget, not many yards from where the biplane left the ground. It is all that has ever been found of *L'Oiseau Blanc*.

While passing just north of Le Havre, the last of the five French air force escort planes prepared to turn back. The pilot, Captain Venson, probably pulled close, shot the pair a stylish salute, and popped the stick into the corner of the cockpit, his machine rolling away and rapidly diminishing. Whatever he did, he was the last person to see Charles Nungesser and Francois Coli alive.

The woodsman's secret. Anson Berry was not a happy man unless he was alone in his Maine woods, preferably in a canoe on the East Machias River, near his camp at the Wigwam Riffles. "He could paddle that canoe up through the riffles and *nobody* could follow him," says one elderly resident of Machias who knew Berry in 1927. Berry had once gone off to be a cowpoke in Montana, but came home to be married. When his wife died in childbirth, the experience soured him so badly that he gave the infant to his sister and went into the woods for the rest of his life.

On the afternoon of May 9, 1927, Berry's woods were jarred by a rude interruption. "Did ya hear that damn *plane?*" he angrily asked an acquaintance several days later. Airplanes were rare enough in Maine in 1927 that there was no question about *which* damn plane he meant: it was the same one heard, flying low, by several other Machias folk who were driving the dirt roads or fishing the icy streams northwest of the town.

None of the townspeople actually saw the airplane: the ceiling was low, the weather was gloomy, and its pilot would have been doing what is today called "scud-running"—stumbling through the thin slice of sky between clouds and the hard place, probably slaloming along the corridors between ridges and hills whose summits were obscured in the mist. Nor did anyone make an exact note of the time, but it seems to have been about 40 hours after *L'Oiseau Blanc*'s takeoff. And as near as Nungesser and Coli had calculated, based on performance tests of their engine, they carried 41.3 hours' of fuel.

Some locals say Berry heard the biplane crash. "The engine went to sputterin'," Albert Mattatall recalls being told by Berry, "and then he heard silence and a big crash." Another old-timer says Berry's claims went even farther: "He told me when I was a boy that he'd seen the big swath the plane cut through the trees." Berry was known to enjoy a bit of storytelling, however, and exactly what he saw or heard was lost forever when the consummate canoeist drowned in 1936.

But if he was telling the truth? It's almost certain that a man like Berry, who had found a home in the forest where people "from away" (as Machias natives still refer to outlanders) weren't welcome, would have searched out the crash site to hide it from further investigation as best he could. If, as many said, he had a still and made moonshine, he'd have buried the bodies and covered the splintered wreckage with pine boughs, which in a season or three would have cloaked an airplane's wood and fabric forever. "Don't want no damn state troopers back here," he'd have muttered to himself as he did it.

The deathbed confession. In 1979 an old French fisherman decided to free his soul, he said, of a burden of dishonesty he couldn't bear to take to the grave. On May 8, 1927, according

Alain E. Cohen.

Captain Francois Coli and Captain Charles Nungesser, navigator and pilot of L'OISEAU BLANC posing just prior to their attempt to fly Non-Stop from PARIS to New YORK.

to his story, he was fishing in the English Channel, off the French coast near Le Havre. It was foggy—a damp, unmoving mist that hinted at clear skies above but limited vision to a quarter-mile or less at sea level. Suddenly, he heard the sound of an airplane drawing nearer, then the tortured rasp of a machine out of control and an awful sound—probably like a watermelon dropped onto concrete. He watched as a blocky white biplane spun into the sea barely yards from his boat and sank without a trace.

When the wide-eyed fisherman returned to port, he reported to the authorities the crash of what he knew was

EYEWITNESSES EVERYWHERE FROM IRELAND TO LONG ISLAND SOUND REPORTED SEEING *L'OISEAU BLANC* OVERHEAD.

L'Oiseau Blanc—no surprise that he recognized the airplane, for all of France was filled with news of the takeoff of two national heroes. But there was money quickly slipped into his hands—more than the fisherman had ever seen—followed by hushed conversations and threats that he must never reveal what he knew.

Based on the fisherman's story, some people began to speculate that *L'Oiseau Blanc*'s transatlantic attempt had been a hoax. This theory is believed by Pierre Lissarague, a leading French aviation historian and former director of the Musée de l'Air. According to the skeptics, Nungesser and Coli had planned all along to set the airplane down in the Channel with "engine trouble," proving the efficacy of Levasseur's water-capable design without going all the way to New York to do it.

Unfortunately, the theory goes, the Channel was socked in when they got there. Nungesser let down into the fog anyway, but too late discovered his limitations as an instrument pilot. *L'Oiseau Blanc* went into a spin, ending the hoax as well as Levasseur's hopes.

When Nungesser's cousin, Roland Nungesser, heard of the fisherman's confession, he was furious. As a member of the National Assembly, Roland couldn't afford to see his vote-getting family name tarnished. He demanded, and got, a full government investigation of the allegations.

The report was as exhaustive as could be expected, including little but contemporary newspaper accounts, meteorological records, testimonies from a few living witnesses, and some doubtful sightings. *L'Oiseau Blanc* had been reported overhead everywhere from Ireland to Long Island Sound, though the latter sightings were doubtless of white U.S. Coast Guard flying boats searching for the overdue biplane. But the French investigation concluded that some previously unpublicized sightings in Newfoundland were solid enough to strongly suggest that Nungesser and Coli had made it at least that far.

The report also concluded that any further investigation would have to be undertaken on this side of the Atlantic. It already had been, in fact: by a writer with one of the more unusual résumés in the business.

Leatherface. In 1973 Gunnar Hansen, a bearish, slightly maniacal-looking former University of Texas graduate student, was hired to play the role of Leatherface in *The Texas Chainsaw Massacre.* The gruesome cult film, which introduced the use of a McCulloch as a kitchen accessory, earned some $50 million in three years. Hansen earned a mere $800 for his work, plus $2,000 in royalties.

So instead of turning to the screen for a career, Hansen became a writer and moved to coastal Maine (much like his native Iceland), where he became the man who first went public with the tales of Anson Berry's "damn plane." In June 1980, *Yankee* magazine published one of his articles tying together the rumors of the crash. One person who read it was a pilot and old-airplane enthusiast named Richard Gillespie.

A couple consumed. Gillespie was an aviation insurance agent in Philadelphia at the time. "I stuck a copy of Gunnar's article in a desk drawer, where it festered," he recalls. "That last paragraph just bugged me: 'Perhaps someday a searcher will come upon the White Bird's rusted engine.' "

In 1984 Gillespie met Patricia Thrasher, the owner of a successful household cleaning service in Williamsburg, Virginia, and told her of, well, not a *grander* job but certainly a more emotionally rewarding one. "I pulled that clipping out and decided that *this* is what I want to do," Gillespie says. He and Thrasher gave up their jobs, bid farewell to Yuppiedom, and became full-time aviation archeologists. Married in 1985, they now live in a tiny frame house across a cornfield from the runway of Summit Airpark in Middletown, Delaware. Between them they earn less than $20,000 a year while running a growing but struggling organization called The International Group for Historic Aircraft Recovery, more commonly called TIGHAR, as in "Go get 'em."

"I might have to take another job to help support us, but I've never seen Ric so happy as he is now," says Pat Thrasher. "I feel good about what I'm doing," Gillespie agrees. "I feel that it needs doing and that we're the people to do it, which I never felt during my career in insurance."

What he is doing that feels so good is slashing through a swampy forest outside Machias, Maine, with several TIGHAR searchers and me following in his wake. Pine boughs rake our faces, their needles slipping into every crevice of our clothing, as mosquitoes sample our bodily fluids and sweat dampens whatever the swamp has missed. A mile away, in a camp only moderately more comfortable, Thrasher singlehandedly oversees the logistics of feeding and housing a dozen TIGHAR members in three olive-drab army tents traditional enough that were Nungesser and Coli to wander out of the woods, they'd probably think they were back on the Western Front.

Gillespie and Thrasher's enthusiasm, dedication, and scholarship—both majored in history at college—have drawn together an unlikely band of zealots for Project Midnight Ghost. The party includes a tall, bearded, erudite Air Force civilian helicopter mechanic from Florida; a Machias dentist who owns enough vehicles, woodsman's toys, and mechanical imple-

Coli and Nungesser leave The coast of France Charles E. Colbert
8 may 1927

ments to serve most of TIGHAR's needs (what he doesn't have is borrowed from the Maine National Guard); an early-retired Exxon executive with a Harvard honk who has less interest in airplanes than in ham radios but has been drawn to the search nonetheless; a short, shy accountant from New Jersey so convincingly Rambo-ized by his surplus store camouflage poncho and machete that he is quickly dubbed the Angel of Death; and a journalist clumsy enough to break an arm during the search. ("We considered calling [our camp] Wilkinson Falls," Gillespie and Thrasher reported to TIGHAR's membership in a later newsletter, "but decided that was a bit much. Still, we take our work much more seriously than we take ourselves.") The team has been steadfastly gridding, marking, searching, poking, digging, and gridding some more.

In our mess tent one evening, Gillespie toasts a photograph of Nungesser and Coli: "Their courage was adequate to their task. May ours be adequate to do the job they deserve." Patience has also proved a virtue. "When we came up to Machias in 1984, we thought we'd stay the weekend and find the airplane," Thrasher muses. Since Gillespie's first walk in the woods, there have been four research trips and nine more expeditions, each more systematic than the last, each in search of something that deer hunters saw.

The deer hunters. Raymond C. Beck was the first to report seeing a huge airplane engine in the woods outside Machias. He was hunting in 1950 when he came across it "in the Round Lake Hills," near as he can remember. But he didn't say anything about it at the time. When he finally related his story to Gillespie in 1984, Beck was unable to retrace the steps he'd taken as a deerstalker three and a half decades earlier.

Who would come across an airplane engine in the woods and not go home and dial 911? Most deer hunters in easternmost Maine, that's who. This is not some suburban maple grove left uncut by a housing development. These woods stretch unbroken to where they turn into tundra, and they're periodically invaded by paper-company lumberjacks bearing motors and machinery. Some say there's nothing unusual about seeing old engines of all kinds in the woods, motors left over from broken-down skidders and abandoned sawmills. Others say that's

not true—most abandoned engines will be ancient single-cylinder contraptions or old car motors, not 12-cylinder, 450-horsepower French Lorraine-Dietrichs. But the Maine native is a reticent sort, not likely to volunteer information.

Jim Reed didn't volunteer his information until 1985, 15 years after he too saw an engine. A nervous man who speaks in a high voice and wears tinted glasses, he wouldn't be type-cast as a Maine woodsman in a movie called *The Search for L'Oiseau Blanc*, but as a younger man he hunted the woods surrounding Machias every year. *Never* near the Round Lake Hills—he's sure of that. Always in an area several miles to the southeast of those three low mounds.

Last summer Reed was suddenly able to refine his recollections of that day in 1970 when he saw the engine. "I didn't go into the woods where I usually did," Reed said to TIGHAR interviewers on the island of Vinalhaven, Maine, where he now lives. "My partner was going into town, so I rode a ways with him in the pickup and then got out. I walked at least an hour, then I came to a place where I could look out across a swampy area and see the East Machias River about 300 yards away. Then I walked north through a boulder field that was very rough going—I was glad to get out of it. It was somewhere between 45 minutes and an hour and a half later when I saw the engine."

What makes Reed's information compelling is that he was once a mechanic for the Air Force and for Pan American Airlines, and he knows an airplane engine when he sees one. "That's about all I could tell, though—that it was an airplane engine," he reported. "It was all packed with gravel and debris, and I had nothing but my knife to dig with. I remember thinking, Where's the propeller? But the only other thing I could find was a cable, about 20 feet away, that led down under what seemed to be some ledge and rock." Marks of an Anson Berry burial? "I wrapped the cable around my waist and backed up, trying to pull it loose. I couldn't, or it may have broken—I don't remember."

Reed does remember that the engine had a trumpet-shaped "exhaust pipe" that seemed much too big. When Gillespie showed Reed a photo of *L'Oiseau Blanc*'s engine, Reed said, "Yeah, that's it"—pointing to the Lorraine-Dietrich's characteristic bell-mouthed ram-air intake.

The psychics. There was a string attached to one of the early private grants that TIGHAR received to pursue the search for *L'Oiseau Blanc*. "If you take the money," the benefactor said, "all I ask is that you go to the American Society for Psychical Research in New York City and see if they can help."

"Great," Gillespie thought, "there goes our credibility." But the donor was adamant: no psychics, no money.

The tape recordings that Gillespie and Thrasher made of several sessions with two professional psychics provided by the society make for spooky fireside listening as our campfire flickers, Maine coyotes bugle in the distance, and amateur searchers far from home mutter about bear tracks in the woods. One of the psychics, Anne Rylchensky, who frequently works with the New York Police Department envisioning the manner of unexplained deaths, described Nungesser's and Coli's last moments in grim detail, claiming to be able to sense the very pain they suffered. Nungesser, she said, was thrown clear and died of grievous back injuries. Coli's chest was crushed by some kind of dinner plate-like horizontal protrusion in the cockpit. And indeed, *L'Oiseau Blanc* was fitted with a large marine compass on a horizontal bracket at approximately chest height, in the center of the cockpit. Could Rylchensky have known this—and a wide variety of other details about the airplane? Only if, within a single day, she could have determined that the unidentified French airplane that TIGHAR was interested in was *L'Oiseau Blanc* and then done research that took Gillespie and Thrasher months, and a trip to France, to accomplish.

At the time the psychics gave their stories, TIGHAR was concentrating on searching Ray Beck's Round Lake Hills. None of what the psychics said about the actual crash made much sense . . . until Reed came forth a year later and steered the search to a new area. Suddenly, landmarks on the ground, the shapes of lakes, a possible northwestward course from Nova Scotia instead of the generally assumed southwest heading from Newfoundland, and the psychics' descriptions of the pilots' actions—banking, turning—all fit together.

Both Rylchensky and parapsychologist Alex Tannous maintained that the airplane had suffered a steadily mounting mechanical problem, *not* the sudden stop of the engine that is characteristic of fuel exhaustion. Could *L'Oiseau Blanc* have suffered some kind of terminal engine malady minutes before it was due to run out of fuel anyway? The coincidence would be poignant but hardly beyond the pale. The psychics spoke of "a strange smell—like ether." Anybody who has smelled overheated glycol in a water-cooled engine like *L'Oiseau Blanc*'s would recognize the image. They referred to one of the pilots tapping a gauge with his forefinger. Pilots nod knowingly at this, since that's often the first thing you do when an instru-

Fieldwork

Nothing in the forest moves but a half-dozen bleary-eyed men and women stumbling toward the smell of coffee through a chilly Maine dawn. Ice rims a bucket of water left out overnight, and fog wreathes the treetops.

Project Midnight Ghost's three large army tents are sodden with dew and the campfire is cold, but behind us is the bitterest moment of the morning: the frenzied transition from warm sleeping bag to chilled clothing. Those of us who have been here before know to ease the ordeal by sleeping with the next day's duds stuffed into the foot of our bags.

"We call it the Indiana Jones complex," jokes TIGHAR's Patricia Thrasher, explaining why grown men and women pay $45 a day for the privilege of participating in the hunt for *L'Oiseau Blanc*.

Her husband, group founder Richard Gillespie, leads the search, usually wearing bush jacket, white scarf, and proper pith helmet. Experience gained as a Vietnam-era Signal Corps officer shows in his easygoing but firm manner in the field.

Inevitably, outsiders who hear of the project say, "Why'ncha just fly over with some kind of *metal* detector, huh?" Unfortunately, the airborne magnetometers available to civilians are not sensitive enough for such an aerial search; they would also be thrown off by the considerable magnetism of local rocks. Even the portable treasure-hunter metal detectors that several TIGHAR searchers wield are constantly whinnying with false alarms. We've been led to numerous empty oilcans, a logger's peavey, and a length of old chain.

No, the classic foraging line might be the only way we'll find a moss-covered, half-buried, possibly unrecognizable airplane engine in the midst of a forest thick with piny underbrush. So we tramp the woods in side-by-side formations, back and forth like Georgia deputies after a chain gang dropout. "Line discipline" is crucial in ensuring that we sweep evenly, leaving no hummock unpoked, no boulder unexamined.

High school students from the nearby town of Machias join us one day, loping through the woods in adolescent joy at being away from the classroom. They are so giddy, in fact, that we make them sweep each area twice.

"It's an opportunity for them to learn that there's more to history," their teacher says. "You can teach it, as I do, or live it, like Richard Gillespie does." Along the way Gillespie lectures, "If you walk by the engine during five seconds of goofing off, not only won't *you* find it but nobody *else* will until somebody decides, 'Maybe those jerks from TIGHAR missed it back in '86. Let's look there again.' "

Each search area is "gridded"—measured and marked off in search-sized rectangles, first on high-resolution aerial photographs and then on the ground itself with twine and forester's tape. It's like rolling a life-sized map right out on the ground, Gillespie says. We pace slowly through each parcel and then wheel and go back, the only permissible course dead ahead. The lucky ones take up a heading through relatively clear areas, the rest condemned to hacking down stands of pitchy saplings or plummeting through heaps of fallen spruce branches.

Searchers come and go—the briefly adventuresome on weekends, the more committed during the week—and the course of enthusiasm is predictable. At first you think, "What could be so hard about finding a good-sized airplane engine in the woods, forgodsake?" A day afoot suggests the futility of it all.

Then you're launched anew with each adrenaline shock of seeing . . . *There it is!* . . . No, just a square boulder. *What's that?* . . . Damn, a silver-bark birch fallen across a rock, I could have sworn it was an exhaust manifold. . . . *Oh Lord, this is the place, a clearing just like the deer hunter described.*

Let your imagination loose and the forest floor is carpeted with lumps and hillocks that hide the remains of a 60-year-old biplane.

As I tramp through the woods, I sense the presence of *L'Oiseau Blanc*'s long-stilled 12-cylinder Lorraine-Dietrich. The question, I'm sure, is not whether it's there but when we'll find it.

—Stephan Wilkinson

ment panel gauge tells you something you don't want to believe, such as an engine temperature creeping toward the red line. Rylchensky said Coli leaned out of the cockpit and saw "something white" streaming past, over the wing. Could she have known that the airplane's radiators were located on the leading edge of the wing, fed by external hoses from the engine block that might have ruptured?

The psychics also told of the engine's "grinding sounds" and of "vibrations" in the cockpit. An intriguing parallel is that Norman Foss, one of the Machias natives who heard an airplane on May 9, 1927, said at the time that it "sounded like an old-time cream separator." Foss is now deaf and suffering from memory lapses, making it difficult to interview him further. But TIGHAR's custom is to leave no stone unturned. "We went out and found an old cream separator in a dairy museum here in Delaware, and got them to run it for us," Gillespie says. "If it were an airplane engine, you'd sure say it was in a lot of trouble."

While the psychics have provided some tantalizing clues, Gillespie cautions: "We have done *nothing* that is based solely on psychical evidence. But the empirical evidence we do have all makes sense in light of what the psychics said." If *L'Oiseau Blanc*'s engine is found and examination reveals evidence of overheating, doubters of the paranormal will have some fancy dancing to do. But finding the engine . . .

The search continues. After Jim Reed's recollections steered the TIGHAR team from the Round Lake Hills to the general area just west of Second Lake, Gillespie made an air search in a Piper Comanche. He pinpointed a likely ridge line and then approximated what he imagined would have been *L'Oiseau Blanc*'s last moments, when "the engine went to sputterin' " and Nungesser and Coli must have desperately tried to rack the big biplane around to land on the lake they'd just passed. Amid the tattered mist the ridge might have risen inexorably, perhaps never even seen by the two weary Frenchmen in their chilly cockpit far aft as *L'Oiseau Blanc* finally, fatally, tragically arrived in America.

With the view from the air as a guide, the search returned to earth. On September 20 Gillespie and another TIGHAR searcher found Reed's river vista across a swamp, then turned north and discovered his boulder field. Somewhere 45 to 90 minutes' of slow deerstalker's walk to the north, along a path that Reed recalls as being low on a ridge, may sleep all that's left of *L'Oiseau Blanc.*

The biplane's remains would be hidden by snow now. Soon, though, the Gulf Stream will warm coastal Maine for the 60th spring since the crash. But this season there will be something new in the air: a TIGHAR team aboard a French Aerospatiale helicopter equipped with FLIR—Forward-Looking Infrared. If the immense engine block of *L'Oiseau Blanc* hasn't been too thoroughly covered by moss and old foliage, it will glow subtly on the FLIR screen as it casts off the heat absorbed from the still chill sun.

If all goes well, it will also be a French helicopter that lifts the remains out of the forest and a French aircraft that flies them to New York, finally completing the voyage upon which brave Charles Eugène Jules Marie Nungesser and François Coli embarked six decades earlier.

TIGHAR's Several Stripes

The search for *L'Oiseau Blanc* is only one of several missions being undertaken by The International Group for Historical Aircraft Recovery.

Operation Sepulchre, for example, is aimed at exhuming a treasure trove of virtually untouched Luftwaffe fighters from the mid-1940s, including some exemplary early jets. It has long been rumored that underground World War II hangars are scattered throughout Germany. Some were supposedly flooded, sealed, and forgotten at war's end, when salvaging booby-trapped German aircraft was of no interest to an army intent on getting home. One such hangar apparently lies under a wooded hill outside the city of Kassel, and others may be under former Luftwaffe fields that today serve as U.S. Air Force bases.

"There isn't a single Focke-Wulf FW-190 in German hands," says TIGHAR's Richard Gillespie, "and any number of German museums—especially the Deutsches Museum in Munich—would kill to have one of these fighters."

Further along is the group's B-17E Recovery Project. Gillespie and Patricia Thrasher have already started extensive negotiations in Papua New Guinea, where a Flying Fortress crash-landed in the Agaiambo swamp after a 1942 bombing raid.

The airplane, which TIGHAR wants to return to the United States, is a particularly early B-17, built late in 1941. It is one of only three intact Flying Fortresses that saw combat and one of two that actually shot down enemy aircraft. The island nation's government, which initially frowned on the project because some officials feared losing a potential tourist attraction, now seems on the verge of approving an operation to recover what would be the largest aircraft ever exhumed.

Membership in TIGHAR, a nonprofit foundation, costs $25 a year. You get a quarterly newsletter (which includes information on aircraft and aviation artifacts that are collectible though less than museum-worthy), regular project updates, and the opportunity to participate in the group's recovery expeditions.

Sound interesting? Future projects may well involve finding a record-attempting four-engine Soviet Tupolev, which may have been ditched near Prudhoe Bay, Alaska, and searching for the world's sole remaining Curtiss Condor, rumored to be in Bolivia.

—Stephan Wilkinson

The Methuselah Project

Francis Everitt has spent almost his entire career preparing for one experiment in space that will prove Einstein right. Or wrong.

by Jack Fincher

James Sugar/Black Star

Drop one, and science is out a perfect sphere. Spinning in space, they will let Francis Everitt check on Einstein.

In the right light Francis Everitt looks eerily like a young Albert Einstein. Everitt doesn't believe it, but colleagues do. And it's only fitting. For now that the father of modern physics is dead, few people know the loneliness of the long-distance runner more than this Stanford University professor. Indeed, as the 51-year-old Brit lopes across campus with the measured gait of a habitual marathoner—deadpan, laser-eyed, black hair flying—none of the undergraduates would ever guess he has been working on one experiment since before they were born.

And what an experiment. Sometime in the early 1990s the space shuttle will place in polar orbit a gravity probe bearing a quartet of gyroscopes without parallel—four small spinning spheres that will perform a million times better than any other gyroscope. If successful, says the National Academy of Sciences, the experiment will be "a landmark . . . a towering achievement."

For almost a quarter-century Everitt's physics and aerospace task force has been devising a revolutionary method of testing Einstein's general theory of relativity. The famous formula $E=mc^2$ represents Einstein's *special* theory of relativity. It deals with the behavior of objects, particularly subatomic particles, as they near the speed of light. His *general* theory adds gravity to the equation, though physicists are not totally satisfied with the result.

Hence the need for further testing. After all, Einsteinian relativity appears

to offer the best insight yet into the cosmology of the expanding universe, as well as such far-out astrophysical phenomena as quasars and black holes.

According to Einstein, gravity is not a force exerted instantaneously by one object on another, as Sir Isaac Newton theorized 300 years ago. Nothing, Einstein insisted, travels faster than light. Gravity is instead a curvature in the space-time continuum caused by objects that dimple its fabric, like the contouring effect of a cannon ball slung in a circus net. Seen that way, the Earth no longer seems like one of those numbered bingo balls suspended more or less in midair, but rather a celestial slot car traveling on a looping track we cannot see but call its solar orbit.

If Einstein is right—if gravity is subtle architecture—then as Everitt's sensitive gyroscopes move through the warped space-time around Earth, they will gradually be pulled around in the plane of the orbit. In other words, line up a gyro on a distant star and by the end of a year it should have turned through a tiny angle: 6.6 arc-seconds, in physicists' parlance. (An arc-second is the angle the sun moves in the sky in 15 seconds.) If you wanted to watch the gyro turn through 360 degrees, you'd have to wait nearly 200,000 years. Even Everitt isn't that patient.

Another effect predicted by Einstein that the probe will measure is even smaller and, if possible, stranger. Just as a moving electric charge creates its own magnetic field, so the rotating Earth is thought to generate an entirely new kind of gravitational field: gravitomagnetism. Such a field, which has never been detected, should exert a twisting action on the gyroscopes as they are dragged along with the Earth's rotation. How big is this effect? Everitt grins. "Not very—about 44 milliarc-seconds per year. That's less than the width of a human hair seen, if it could be, from 10 miles away. And we are trying to measure both Einstein effects to better than a milliarc-second."

The Stanford project is funded by the National Aeronautics and Space Administration at a projected cost of $170 million, all for a satellite that will look like a giant solar-powered garbage can. Inside, the near-perfect spheres will spin within a near-perfect vacuum in a near-zero-gravity magnetic field at a temperature of nearly absolute zero. The satellite, its position fixed by a superprecise telescope on the guide star Rigel, 300,000 light-years away, will telemeter back to Earth data indicating whether the gyros turn slightly over the course of a year, in keeping with Einstein's prediction.

Although Everitt has emerged as the leader, the idea for the experiment wasn't born on his watch. He was still in England, having just completed his Ph.D. on paleomagnetism and busy measuring the minute magnetic fields of common rocks, when three Stanford professors hit upon a new way to test Einstein using a gyroscope in space. They were William Fairbank, Leonard Schiff, and Robert Cannon. "Several major features of the experiment were thought of during the first few months," remembers Cannon. "Fairbank thought we'd probably launch by 1966. I said, 'Nonsense, it'll take until 1976.' "

Everitt, who dryly describes himself as a "drained brain," had decided to cross the Atlantic to the University of Pennsylvania. There, he helped discover a phenomenon called third sound, a misnomer for a wave motion that transmits miniscule movement over enormous distances on a microscopic film of superfluid helium. His offbeat credentials stamped him, in the words of Fairbank, as "a physicist looking for a far-out challenge." Stanford had it. Welcome aboard, Francis.

The first and most enduring problem they had to solve was how to measure the spin direction of the gyroscope's perfectly round sphere. The key, they decided, was superconductivity: the fact that some metals lose their electrical resistance at temperatures near absolute zero. Superconducting metals, it turns out, also become magnets when spun. That spin, Fairbank and Everitt figured out, could be used to mark the gyro's tiny divergence from the plane of the Earth's orbit.

Some of the other trials and tribulations that awaited Everitt and his colleagues illustrate what makes the project, in the words of a team member, "the most challenging technological feat ever attempted"—a feat, not incidentally, that has led to 27 Ph.D. degrees, with more on the way:

Bump in the light. In a near-perfect vacuum, even the drag of a few air molecules or radiation pressure from sunlight could nudge the gyros and skew the data. The problem was solved by installing a proxy sphere inside a cavity near the gyroscopes, which was shielded against all such disturbances. Continuously checking for acceleration of the gyros, the proxy shoots out jets of gas to make the spacecraft "chase after" the balls and correct itself. The result: a drag-free satellite.

The go-around about round. A machine invented by NASA scientists that makes almost perfectly round balls wasn't quite good enough. So spheres for the gyroscopes, which are made of pure quartz and coated with a layer of the superconducting metal niobium, are polished and measured with a computerized device developed by the British firm Rank Taylor Hobson. The firm sent an engineer to Stanford on a special fellowship to work out the details. The instrument now turns out spheres so smooth that, if they were the size of the Earth, the tallest mountain would stand only three feet high.

Disharmony of the spheres. When the balls were first coated with niobium and suspended in an electrical field for testing, some of them exploded. The physicists were baffled. Cannon, an aerodynamicist, hit upon the problem: self-exciting oscillation, at its simplest the curious kind of dynamic coupling that causes a flag to flap when a steady breeze blows against it. Redesigning the electronics did the trick.

The one-ton thermos. Just to keep the instruments cold enough to function for a year requires a custom-crafted liquid-helium container. The original design was so cumbersome that the satellite would have weighed three tons and cost nearly $300 million. Facing rumors that federal funds might be cancelled, the team took just six weeks to cut weight and cost in half. Says Everitt with a small smile and a bow to Samuel Johnson, "When a man knows he is going to be hanged in a fortnight, it concentrates his mind wonderfully."

The emergency also raised larger issues about how such a complex experi-

ment should be managed. "Obviously we weren't going to build the spacecraft on campus," Everitt says. "But much of the trickiest technology only exists here in the laboratories and in the brains and fingers of a small group of physicists and engineers with little experience in flight programs. Somehow, a marriage had to be effected between our group and an aerospace company." The answer was to join forces with Lockheed, which now serves as subcontractor for flight hardware and systems engineering.

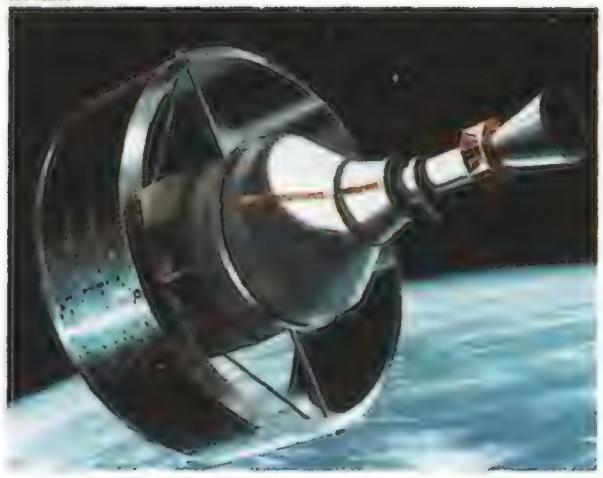
Fortunately, the project has never been an all-or-nothing proposition that would make failure a costly anticlimax. On the contrary, Everitt notes that technical spinoffs have yielded a cornucopia of valuable advances: drag-free satellites, the first of which was launched for the Navy in 1972, more precise optical telescopes, magnetic shielding for superconducting computer circuits, a variety of hardware for gravity-free experiments in space, not to mention a new federal standard for measuring spherical volume.

Looking back, what made for the group's success? In an era when committees seem to produce more camels than horses, what kept fresh the flow of ideas among 10 to 50 changing physicists and engineers?

What made it all possible, Everitt thinks, were the complementary natures of his three mentors. Cannon, who keeps on his desk a family-style photograph of his 18 current doctoral candidates, believes uppermost in getting good people: "My son works for a guy who owns a huge cattle ranch," he says. "I once asked the rancher what the single most important ingredient in his success was. He said every year he rides through his herd and picks out the stock he's going to build on. If there's a secret here, that's it. Everybody involved is just awfully competent."

With Fairbank, says Everitt, it's the deceptive quality of his interaction with other people. "I used to be staggered by the naive questions he would ask, embarrassed to ask them myself. It took me a while to realize what a virtue that is, not being afraid to ask childish questions. By the end of a meeting, he's honed in on the real issues that most people don't come to grips with for fear of exposing their ignorance."

Lockheed



The gravity probe's delicate cargo may answer a key question about the universe.

As for Schiff, who died of a heart attack in 1971, his legacy was a double-edged spirit of intellectual fearlessness. Cannon recalls a meeting of relativity theorists at which Schiff rose after the remarks of another physicist and announced, "Part of that is correct and part of it isn't." He then spelled out what wasn't. "I hadn't expected controversy," the chairman began, but Schiff cut him short. "Oh, it isn't controversial," he said. "It's just wrong."

On the other hand, Schiff once came to Cannon's office with a sheaf of calculations he had done on the feasibility of liquid gyroscopes. Cannon, having attacked the problem years before, had to tell him the idea simply wouldn't work. Schiff just dropped what must have been 20 hours of hard work in the wastebasket and said, "Oh? Why is that?" "His performance, in dishing it out and taking it, was entirely symmetrical," laughs Cannon.

But through it all, say his colleagues, the linchpin has been Everitt, who is lauded for the diplomacy of a Talleyrand and the patience of Job.

"I don't know anyone else like him," says Cannon. "How much of what we admire he brought with him and how much he acquired from this extraordinary experience, I couldn't begin to say. He has marvelous insight into what's going to be important." And, says Cannon, who once served as U.S. undersecretary of transportation, he has an astute political perspective. "When you hire a young man in pure laboratory physics, how can you expect you're going to get that? But it helps in keeping people motivated, as well as bringing in the money. He's also extremely amusing about it all. We once had a full-dress review by a committee of distinguished scientists and engineers and they spent a full week trying to find something wrong. When they left, Francis said it wasn't quite fair, you know, since we'd had 20 years to think about this and they'd only had a week!"

Everitt is so focused, in fact, that the possibility of failure never fazes him. Cannon learned that when a government official, shown a graph plotting the prospective one-year findings of the mission, remarked, "Well, Francis, looks as if you'll know at the end of the first three months whether you've thrown away 25 years of your life." Says Cannon, "I don't think Francis even heard him. He was too busy thinking about the next briefing chart." Everitt steadfastly maintains that he did hear and did chuckle, but adds, "We were in a big hurry that day."

All the same, Everitt freely admits he probably couldn't have stayed the course had it not been for a diversity of outside interests. One of five children born to a London patent attorney and a strong-minded woman who had been a suffragette, he is a pillar of the Episcopal church. He makes silver jewelry. He writes about the philosophy of scientific theory and experiment, and has published a biography on the British physicist James Clerk Maxwell. And when he can, he runs. (He missed his most recent try at qualifying for the Boston Marathon by four minutes.)

But when it comes to the inner workings of the relativity project and its secrets, it's best to let Everitt speak for himself: "There are two principles that few people understand because they're so obvious. There has got to be a genuine need and there has got to be goodwill. These are platitudes, I suppose. But perhaps it's as simple as saying that great truths are platitudes in action.

"Besides, I've had days of being crazy but never a day's boredom. And after all, I'm certainly not the first scientist to engage in a marathon experiment. Why, James Watt worked on making a better steam engine for 17 years."

And of course there's always the idea that Einstein, even the great Einstein, was wrong. What then? Now *there's* a problem for you, Francis. ✈

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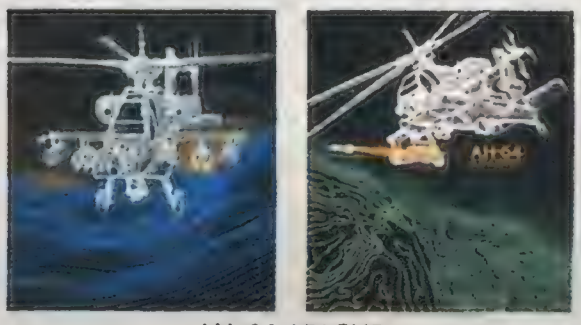

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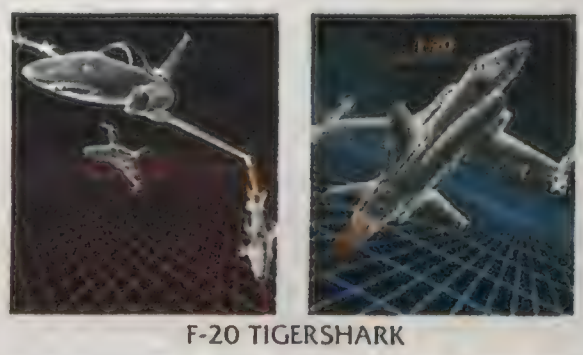

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A Gift of Flight

Gary A. Michel

Gary A. Michel

The Dayton Air Show provides an inside look at aviation. It's also perfect for passing on the legacy of flight, as Craig Michel recently learned from his father.

Onboard the USAir flight to Dayton, Ohio, I looked over at my son Craig and thought about my first encounters with aviation while growing up in the 1950s. Remembering the richness of the simple experiences my father shared with me, I hoped to pass the legacy on to Craig.

Born seven years after the Apollo *Eagle* had landed on the moon, Craig was largely unimpressed with airline travel, military aviation, and even the space shuttle. I wanted to nurture in him an appreciation for flight as one of our most inspiring, if commonplace, achievements. A pilgrimage to the Dayton Air Show, a true celebration of flight, seemed the perfect answer.

My father never saw an air show, nor did he know very much about airplanes, but he always took time to watch them pass overhead. We lived in New York City, and we'd slow down on the Grand Central Parkway, where it curved past La Guardia Airport's neon-lit hangars, to watch an inbound airplane pass over the approach lights that straddled the highway. When headed toward Long Island, we'd stop at a sandy spot along Rockaway Boulevard where ripples of strobe lights pulsed toward runway 22 Right at Idlewild International. Great airliners thrummed overhead, settling toward land after their transatlantic flights. The syrupy, metallic smell of their exhaust washed down over me, a remnant of flight to be inhaled and savored.

One blustery November day in 1959 my father took me to Idlewild to see a sparkling new Douglas DC-8 that United Airlines was inaugurating into service. We waited with other families in a long line that snaked across the ramp to stairs parked at the big jet's forward entrance. Neither the wind nor the wait mattered—I was standing on the same ramp as that colossal flying machine. From the moment I touched its cold skin and tried to comprehend the forces that could lift its sleek mass into the air, I substituted the DC-8 in my notebook doodles for the spaceships flown by Flash Gordon, Commando Cody, and Captain Video. Here was something fantastic that I could actually touch.

In those days, a seventh-grader didn't need to remember many numbers to get by in life. My indispensable numbers were address, telephone, and 685.3. Every Saturday morning I cruised through the aviation books shelved under that number at the public library. They ushered me into hangars and airfields full of strange and exotic aircraft, and I knew that someday I would touch them, see them fly.

For my 13th birthday, my parents gave me a pair of binoculars. From the roof of our apartment building I could view DC-6s and DC-7s, Constellations, Convairs, and Electras just after takeoff from La Guardia. They would materialize through the haze over Randall's Island, and I could hear the muted rumble of their engines as they climbed out over the George Washington Bridge. Those same binoculars came into use again some 26 years later, as Craig and I watched the progress of Halley's comet.

Now, after months of anticipation buoyed by Craig's newfound interest in my aviation books, aircraft models, and student pilot's license, we were about to descend into aviation's mecca for a three-day weekend. The Wright brothers had done much of their aerodynamic research in their local bicycle shop. And much of their flight testing took place in a field that later became Wright-Patterson Air Force Base, nine miles east of the city whose motto is "Dayton—Birthplace of Aviation."

When our flight arrived, the morning air was already thick with heat and humidity. Our landing was delayed 10 minutes while the Thunderbirds, the Air Force's high-tech barnstormers, slashed the sky with the intricate maneuvers they display upon arrival. While we circled, I wondered if the Wrights had ever seen their hometown from 10,000 feet. Probably not.

Taxiing to the terminal, we got our first look at the air show—dozens of brightly colored tents and swarms of people surrounding massive aerodynamic shapes. Our plan, though, called first for a visit to the Air Force Museum at Wright-Patterson.

When the panorama of hangars, missiles, and aircraft hove into view, I felt a deep sense of fulfillment: the dream machines of my youth were here, along with their offspring, and mine. Wandering through the exhibits, Craig seemed to have fallen through a looking glass, straight into the 685.3 aisle. He was in a new and obviously exciting land. After catching his breath, he started taking pictures of everything within range. I understood immediately. From slightly different vantage points we were overloading the same emotional circuits—and that subtle shared satisfaction was a nice feeling.

We leapfrogged through a smorgasbord of magnificent airplanes, pulling each other from one display to the next. Craig hovered near a B-17, one of his favorites since its starring role in a TV episode of "Amazing Stories." I was carried away by the long-legged, delta-wing General Dynamics B-58 Hustler and the round-nosed Lockheed YF-12A interceptor, forerunner of the SR-71 Blackbird. We were on a magic carpet ride where past, present, and future merged into a reality better than imagination. But the best was yet to come.

We were among the early arrivals at the air show the next morning. Late July thunderstorms had left the Dayton airport soggy, but county fairs and air shows alike are incomplete without some mud to squish through. We began our day with a tour of the dazzling display of aircraft on the ramp. Craig galloped from F-15 to F-16 to A-10 and back to F-16—an obvious favorite with its exciting yet toy-like appearance. And when the pilot of a SAAB SF340 airliner powered up its state-of-the-art instruments, with Craig sitting in the cockpit, he looked like Captain Kirk on the bridge of the *Starship Enterprise.*

The burgeoning air express industry was also present in force. A United Parcel Service Boeing 747 humbled the crowds with its sheer presence. And Emery Worldwide's updated DC-8 stopped me in my tracks—I was overcome with nostalgia as I recalled the DC-8 that I toured with my father.

What a sweet continuum. Here were lines of children touring new and old aircraft with parents who likely experienced the same ritual a generation earlier. An Air Force pilot brought in a North American T-39 for display on his last flight before retirement, and received the traditional champagne dousing from his son, also an Air Force pilot, who arrived in a Northrop T-38 trainer jet. Generation to generation. Airplanes. Powerful stuff.

The circle was unbroken, both in the love of flight and in the shape of technology. The Wrights cracked the mystery of flight partly through the use of a control surface forward of the wing. The North American XB-70A Valkyrie supersonic aircraft on display at the museum has returned to a similar design for stability at slow speeds. And during the air show a new B-1B bomber flew shortly after a replica of the Wright B-model Flyer performed, which was built in Dayton and was buoyed by community pride as well as the force of aerodynamic lift.

By midmorning the heat and humidity had slowed our pace, and we sought shade under a Boeing 727. To commune with an airplane you must experience it with all your senses—the opportunity to do so is one of an air show's greatest features. The shows pick up where museums leave off, because the aircraft are ready for nose-to-nose inspection. Airplanes appeal powerfully to our sense of touch—their ingenious curves, precise leading edges, and smooth textures irresistibly lure human hands.

When the Thunderbirds made their appearance in the early afternoon, an overcast forced a low-altitude show. Even without towering loops, six F-16s command every ounce of your attention—the raw power of their afterburning engines rips through the air to beat on your body and mind.

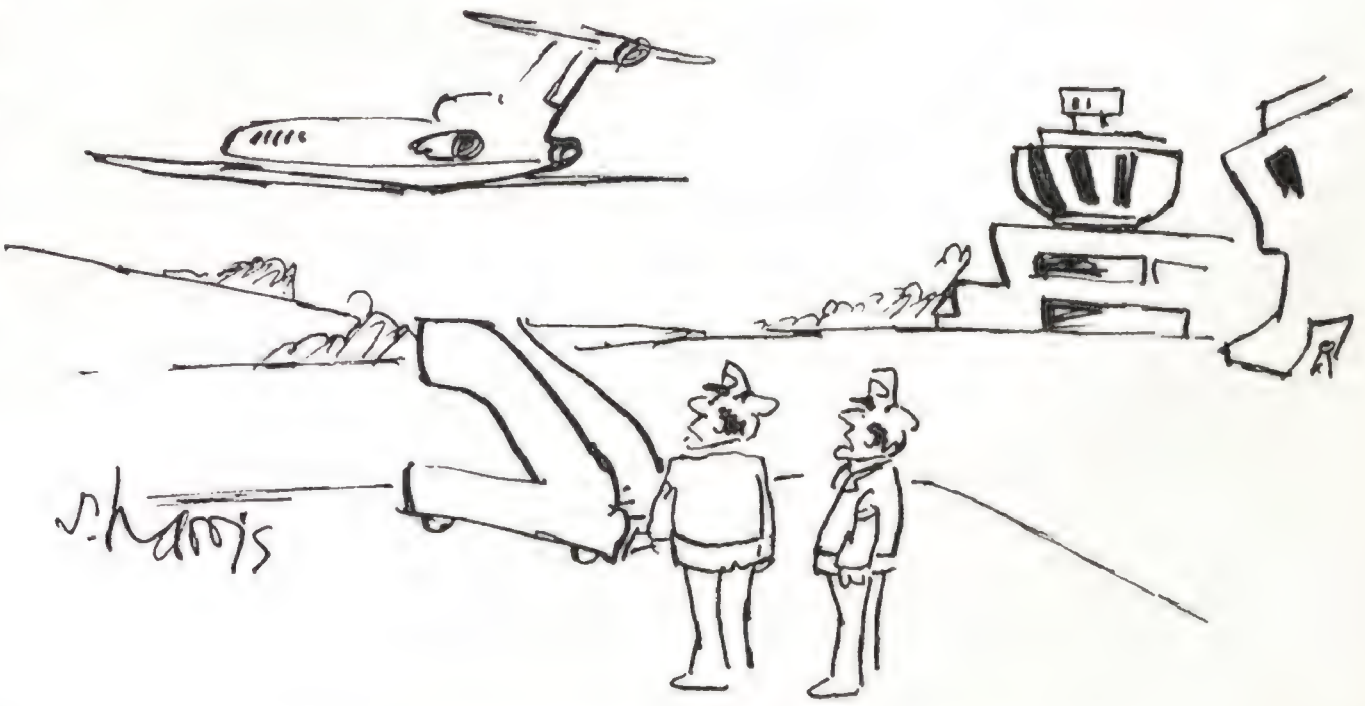
Indeed, the ultimate message of any air show is that the air is the medium. The Wrights understood the physics of this medium, and now the crowd learns. Streaking through the humid air, the F-16s demonstrate vividly how hard their wings are working, carving lift from the atmosphere and leaving sheets of vapor where it is squeezed from the air. It's a true look at the power of flight.

Early the next morning we headed back to the museum, stopping at the Wright Brothers Memorial National Monument along the way. Located on a quiet hilltop, the marker overlooks what used to be the pasture where the Wrights tested later versions of their Flyer in 1904 and 1905. A Wright-Patterson runway now occupies the site. As Craig and I drank in the serenity, a British Handley Page Victor took off from the runway and roared directly overhead, as if to summarize Dayton's lessons.

Later that day we boarded a flight home, laden with sacks of brochures from the show and a huge bag of of popcorn. But while we sat on the ramp, Ohio Air National Guard A-7s conducted simulated air strikes on the airport as the air show went on. Our scheduled departure time took a direct hit. The continuum had really come full circle: from routine to celebration to routine aggravation. But I also thought of the troubles the Wright brothers must have faced, and they persevered.

Once aloft, we relaxed with handfuls of popcorn and a grand view of the sky and the countryside below. Craig was soon asleep, exhausted by a trip that taught him more in three days than could be learned from all my books. Perhaps his curiosity will carry him to heights I still dream of. But just as important, he has learned the importance, and hopefully some of the joy, of passing on the legacy.

—Gary A. Michel



"I thought that automatic pilot was getting a little too smart."

Mon.

Tues.

Thurs.

Fri.

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Wed.

A scene from the motion picture, "RAN."
Directed by Kurosawa, inspired by "King Lear."
Sygma

Sat.

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Why it happened. What it means.

Breaking the Ground Barrier

On December 17, 1903, Wilbur and Orville Wright realized their dream of making a powered flight in a heavier-than-air vehicle. The world reacted with . . . actually, the world didn't react at all.

As late as January 1905, the only eyewitness accounts of Wright flights appeared in the beekeeping journal Gleanings in Bee Culture. *In January 1906,* Scientific American *printed an article titled "The Wright Aeroplane and Its Fabled Performance," which discussed the brothers' "alleged" flights.*

The sense of disbelief and indifference was shared by the government. In January 1905, the Wrights wrote to their Ohio congressman, R.M. Nevin, in an attempt to interest the United States in their invention. Nevin passed the letter on to the Secretary of War, who passed it on to the Board of Ordnance and Fortification. The Board sent the brothers a polite turndown, explaining that it received many requests from inventors who wanted funding for their flying machines, and had "found it necessary to decline to make allotments for the experimental development of devices for mechanical flight." The Board overlooked the fact that the Wrights had made no request for funds at all.

Throughout the next few years, the brothers would be in occasional correspondence with the Board, but the government was not encouraging. In the meantime, the Wrights gained support in Europe, but interest there faded, mainly because few believed that the Wrights had really flown.

This all changed in 1908 after a series of spectacular flights by the brothers on two continents. In August, Wilbur began flying for enthusiastic crowds in France. Later that month Orville, accompanied by his two mechanics, the Charleses Taylor and Furnas, arrived in Washington, D.C., to demonstrate his craft to the U.S. government at nearby Fort Myer, Virginia.

Orville made his first flights for a small crowd on September 3. Representing his father, the president, was Theodore Roosevelt Jr. He reported that "the crowd's gasp of astonishment was not alone at the wonder of it, but because it was so unexpected. I'll never forget the impression the sound of the crowd made on me. It was a sound of complete surprise."

On September 9, Orville made three record-breaking flights, one with a passenger. He flew even longer on the next day. Witnessing the flights of the 10th was sculptor Gutzon Borglum, who would later carve history of his own by sculpting the faces of four presidents on the side of Mt. Rushmore. An avid aviation enthusiast, Borglum was astonished by the flights, and that night wrote the following letter.

Despite the successes, Orville's trials at Fort Myer would end tragically with an unhappy first. On September 17, Wright crashed while carrying a passenger, Thomas Selfridge. Selfridge, mentioned in Borglum's letter as "a fine young enthusiast," became the first person killed in an airplane crash.

Washington, September 10, 1908.
11.33 p.m.

My dear Ned:

Well, hell's popping—the gasoline motor is in the air, and man with outspread sheets is astride of it! I've just left Major S. and P., who dined with me at the Metropolitan—a simple dinner, but our spirits were as if charged with champagne from the excitement of the afternoon. Orville Wright has broken all previous records. He flew 67 minutes in a 16-mile wind, handled his pair of planes like a chauffeur, and rode the air as deliberately as if he were passing over a solid macadam road.

Nothing I have ever seen is comparable in action to this gliding bird save the ice-boat. There is no action of the "wings," so you do not think of birds. It has life, power, and selects its course, holds its position, so that it is unlike and unrelated to the gas bag. It is so simple, it annoys one. It is inconceivable, yet having seen it, it now seems the most natural thing in the air. One is amazed humankind has not built it before.

We returned from the Fort with Selfridge—a fine young enthusiast, who will fly this machine as soon as it becomes the property of the Government. Selfridge has been "learning a good deal about what not to do at Baddock, in the science of aeronautics," as he puts it.

I'm sorry you and father could not have been with me. I would have given anything to have had him see what I have seen today. This is not experiment. Man has put, safely and forever, his shod heel into the blue heavens, and glides about as upon ice. Wright has added power, a rudder of a piece of cardboard, and will rub out the boundaries of the world. The pigeons followed the plane around and around, but the pace was too great and the little white things, like mosquitos, fairly fretted in their efforts to get near the wonder.

We left town about 3:30 in a Georgetown car; at the bridge we transferred to a Fort Meyer [sic] car, arriving at the "parade ground" about 4:30—a dusty, fairly level, ungraded plain, paralleling the Arlington Cemetery. At the far end a small shed was pointed out by the motorman as the aviary where the new bird was roosting. A few autos were on the ground, small groups of people moving about or waiting, and an occasional trooper galloped over the space. I was with P.; we alighted at Arlington and in consequence walked the entire length of the field, which was restful, for I was keyed to the breaking point in anticipation of the first view, my *first impression* of this aircraft, that had for years been the labor and the secret of two simple men in Ohio.

The shed is a simple barn-like affair, built of flooring, the end open. Within stood the most unlikely, spider-like frame, with twin cotton covered, horizontal frames, one above the other, about six feet apart. There is nothing about the contraption that would suggest to the lay mind its possible use, should he find it unattended in a field; nothing that would suggest to him what it might do or that it was built for anything in particular.

It has a motor engine resting on the bottom plane near the center; it has a pair of propellers or fans resembling shaped fence boards stained green; a seat wide

"The gasoline motor is in the air, and man with outspread sheets is astride of it!" NASM

enough to hold two, just in front of the engine; the whole directed by two or three wooden levers. Its upward or downward movement, when under power, is controlled by two small planes ten feet in front of the aeronaut; a pair of rudders to the back, guide to the right or left.

The machine is put together as casually as a boy would do it and could be duplicated for less than a thousand dollars. Everything about it is as obvious, once seen, as it is amazing. I had conceived nothing of the kind; there was nothing that met the layman's idea of a flying machine. And actually it does not fly, it glides; it is a glider, forced against the air with great power, guided by two sets of rudders, up and down, right and left.

Presently the crowd warned us something was to happen. Wright had arrived—a light-weighted and not an over keen looking man—he passed the ropes and entered the shed, put his hand affectionately on the laundered wing of his Pegasus, and said something to his faithful, foreign-looking assistant. Word was passed about, some troopers gathered, and together, much as boys handle a great kite, they dragged the flyer across the field to a little tripod, a derrick, from which hung a weight, and from which, along the ground, extended a small rail. Upon this rail, resting on a free wheel, the flyer was placed.

The hour had arrived; there was some wind, but orders were given and the motor started. The aeroplane resting on the rail was anchored, and the weight suspended from the derrick was raised. Its falling, through rope attachments, aided the aeroplane to get speed instantly—a kind of push off. Everything was ready; held back of all this, by U.S. troopers, some three hundred spectators had gathered. Col. B. and Gen. W. had joined us and we were all on the anxious tip-toe, watching and noting every move.

As soon as the motor started, the plane gave a slight jump forward. The wind from the propellers drove the hats from the spectators' heads. Wright pulled his cap closely down over his head, took his seat, called to his assistant, and away he slid—close to the ground, much as a duck does as it turns to escape, he swept the weed tops for possibly a hundred yards; then he seemed to mount suddenly, six, ten, twenty feet. At this height he reached the end of the parade ground, turned to the left and now we saw him in side profile. He crossed the short far end quickly, and as he turned towards us the machine was inclined inward. This Wright does deliberately, or the machine skids as an auto will in turning a slippery corner.

Down he came towards us, head on, passed, and in his return directly over us, the machine did skid, caught in the wind. Round and round he slid for an hour and more. All the wonder was in the start, the rise, and in the most conclusive proof that the plane with power took its place at will and maintained it.

The crowd stood open-mouthed, with murmurs of wonder and an occasional toot from [an] automobile horn; then as he passed over us everybody let go in an uproar of shouting and handclapping. The miracle had happened! Nothing can take this step made into space from man.

We grew restless; he could fly as he wished, move as he wished; at the turns the

wind coming over the Government stable billowed, and the aeroplane tossed like a ship. Up it went to quieter air. "Why did he not go to New York," "to Philadelphia," "why not fly away," "why fly continuously around?" We were mad in a desire to see "stunts." Nothing seemed impossible.

He had begun late and the sky began to lose its light and we worried about how to tell him the time. Finally his assistant was helped to the roof of a small barn and then with chalk began with "56," marking the minutes of his flight. He was high up but he saw, and as darkness settled about us he dove down near the roof each round, better to read the numbers. I remarked that this is probably the first sign ever made for sky travellers.

Finally, having made a record, he began his descent from the far end of the field. Down he came, in long sweeps, settling rapidly, then turning upward and down again, on he slid over the tops of the weeds, then stopping so gently—more gently than does a bird.

The crowd broke; everyone raced for the machine. One quaint old lady, who had been left in a small buggy to watch the horse, while her younger folk could be free, whipped up her horse, drove straight to the aeronaut and begged for a shake of his hand. She was one of the few who shook it. Another old couple turned towards their home. "Well," said the old man, "I'm ready to go now," and his old mate drew nearer to him, smiled, and they disappeared into the night.

The curious rushed for Wright; the boisterous shouted and tooted their horns; officers, scientists drew together in groups. We had seen the most wonderful demonstration of heavier-than-air flight ever made. We had seen a simple little pair of planes driven against the air, rise to a height of sixty feet; a machine, weighing in all about nine hundred pounds, heavy as a horse, glide away, directed at will for an hour.

Ned, it's wonderful. The flights will continue, and next week the President will be back. Some public recognition must be made of these men.

Affectionately yours,

Gutzon Borglum

"Wright entered the shed and put his hand affectionately on the laundered wing of his Pegasus."

NASM

Come fly with us!

AIR & SPACE/Smithsonian, a new magazine from Smithsonian's National Air & Space Museum, explores the history, culture, and technology of flight.

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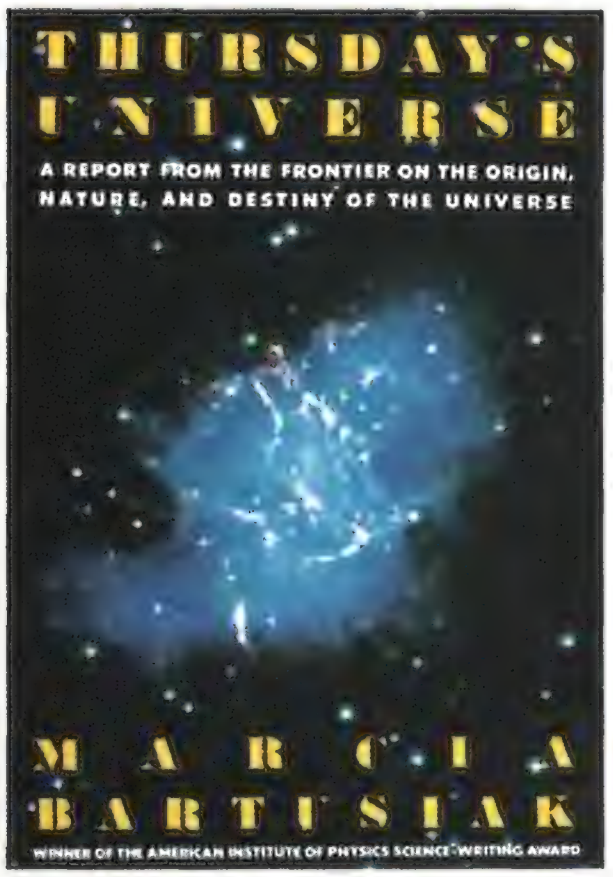
Thursday's Universe. *By Marcia Bartusiak. Times Books in association with Omni Books, 1986. 306 pp., b&w photographs, $19.95 (hardbound).*

To most of us, the star-filled night sky is a vision of tranquility, punctuated occasionally by the silent sparkle of a shooting star. Like the ancients, we may see the cosmos as a Monday's universe, fair of face. Or, like Copernicus and Galileo, we may see a precise, clock-like cosmos—a Tuesday's universe, full of grace.

In her masterful book, science writer Marcia Bartusiak introduces us to *Thursday's Universe*, which has far to go—or rather, *we* have far to go before we can hope to grasp its stunning, beautiful



complexity. It is a universe populated by all manner of celestial beasts, from graceful red giant stars expanding gently as they die to supernovae ending with a blast that lights up the galaxy. Black holes, colliding galaxies, jiggles in space-time called gravity waves, white dwarfs, superstrings— . Bartusiak leads us on safari to sight these cosmic marvels.

Beginning with the birth of stars, which may erupt like a string of firecrackers through a dense molecular cloud, she proceeds to reveal the weird menagerie that these fiery beginnings can engender.

She explains how hundreds of billions of stars, as well as masses of gas, dust, and other cosmic flotsam, are organized into whirling galaxies, and these galaxies into clusters, superclusters, and perhaps even immense bubbles. She details the many theories about the mysterious dark matter that makes up the huge majority of the universe's mass.

Bartusiak also lucidly explains the fascinating machines humans have devised to understand the high strangeness of the cosmos. They include the familiar, such as gigantic optical telescopes, and the flat-out weird, like the huge contraptions of lasers and hanging masses designed to detect gravity waves generated by colliding black holes—if such gravity waves exist.

Finally, Bartusiak explains how daring thinkers have plumbed the unknowable to build theories of how the universe began, and even of what went on before that.

In spinning her fascinating tale, Bartusiak captures not only the celestial elegance of the universe, but also the intellectual elegance of those who ponder it. She writes with considerable wit, and an ear for the pithy quote and the telling detail. For instance, describing the incredible density of matter in a white dwarf star, she writes, "two cups of the stuff would outweigh all the cars parked at a shopping mall during a holiday sale." And she quotes an astronomer who has spent his life studying supernovae cheerfully explaining his preoccupation: "I happen to like explosions."

Her light touch, as revealed in her explanation of the profound physics of "cosmic burps" and depiction of red giants as "the galaxies' worst litterbugs," does more than make astronomy eminently accessible. It also continually reminds us that for all the intense and difficult work that astronomers do, their science remains a prime example of the intellect at play.

Readers of *Thursday's Universe* will come away with renewed respect for the cosmos—and for the people who study it.

—Dennis Meredith, a science writer, is director of media relations at the California Institute of Technology.

Going Solo. *By Roald Dahl. Farrar Straus Giroux, 1986. 208 pp., b&w photographs, $14.95 (hardbound).*

Roald Dahl is well known as the author of fantastic and whimsical children's books, *James and the Giant Peach* and *Charlie and the Chocolate Factory* chief among them. But his latest book, *Going Solo*, is clearly cut from a different cloth. It begins as a vivid account of young Dahl's experiences as a field officer for Shell Oil in East Africa from 1938 until the outbreak of World War II. When England entered the war, Dahl joined the Royal Air Force, and he devotes the bulk of his book to recollections of his days as an RAF flier.

In his introduction Dahl philosophizes: "A life is made up of a great number of small incidents and a small number of great ones. An autobiography must therefore . . . be extremely selective." But of his years in the RAF, he writes, "there was no need to select or discard because every moment was, to me at any rate, totally enthralling."

The first third of the book outlines Dahl's bizarre experiences as a young man in a strange, faraway land. We get to the heart of the book in the sixth chapter, "Flying Training," in which Dahl begins to see the romance of Africa in a different light. The themes of war and survival and the commonplace acts of heroism hold this memoir together and give it not simply coherence but a depth of meaning that seemed improbable at the outset.

What makes this memoir—any memoir, in fact—suspect is the ease with which imagination can trick memory. And to write with irony and detachment of events that transpired nearly 50 years ago is simply a matter of style.

Fortunately, Dahl spares his readers any

sermonizing about the evils of Hitler or the shortcomings of Vichy France. Instead, he soberly tallies up the fate of his flight school classmates: "It is a fact, and I verified it carefully later, that out of those sixteen, no less than thirteen were killed in the air

within the next two years."

Yet before he was immersed in the horrors of air-to-air combat, Dahl discovered the thrill of flying. "I'm having a wonderful time, have never enjoyed myself so much," he wrote home from Nairobi. "After I had gone solo, I was allowed to go up alone for much of the time and it was wonderful. How many young men, I kept asking myself, were lucky enough to be allowed to go whizzing and soaring through the sky above a country as beautiful as Kenya?"

Though there is much in *Going Solo* about the uncommon beauty of the African countryside and its exotic people and beasts, there is more about the inanity of war, the deceptions one passes on in letters to loved ones back home, the sheer terror of engaging enemy aircraft for the first time, and the luck of being a survivor against all odds.

There are times when Dahl's narrative seems inspired by Isak Dinesen's prose, other times when you could swear you have Hemingway in hand: "It was the best rice dish I had ever tasted and I ate it and felt good and forgot about the Germans. 'Wonderful,' I said to the Sergeant. 'You are a fine cook.' " And there are passages that evoke Kipling winding up a tale: "And that was how we captured the German civilians in Dar es Salaam when the war broke out." But above all, you wind up enthralled, captured by the indomitable spirit and goodwill of Dahl's song of himself. It is a song of innocence, a reminder of a simpler time, a time in which he could encounter a Jewish refugee and have the following interchange:

'Is this your land?' I asked him.

'Not yet,' he said.

'You mean you are hoping to buy it?'

He looked at me in silence for a while. . . . 'You are a young man who is flying aeroplanes,' he said, 'and I do not expect you to understand our problems.'

'What problems?' I asked him.

Ah, to be young and naive and alone in a Tiger Moth 3,000 feet above Lake Victoria.

—Douglas McCreary Greenwood, a freelance writer living in Bradenton, Florida, is one of the few pilots who can claim kinship to the Wright brothers—and be telling the truth.

Once They Were Eagles: The Men of the Black Sheep Squadron. *By Frank E. Walton. University Press of Kentucky, 1986. 213 pp., b&w photographs, $18.00 (hardbound).*

Gregory Boyington was at loose ends in the summer of 1943. A veteran of the Flying Tigers—mercenary pilots who flew for China in the opening months of the Pacific war—he rejoined the Marine Corps to find no combat more honorable than a barroom fight, in which he broke his leg. Major Boyington was already 30, old for a fighter pilot, and he desperately wanted a combat squadron.

So did the U.S. Navy, which planned to send the Marines splashing ashore on the Solomon Islands to begin the long, bloody campaign to conquer the South Pacific. Needing air support, the Corps assembled two dozen F4U Corsair fighters rejected by the Navy, along with whatever pilots were within requisitioning distance. The unit was given the identity of a disbanded squadron, VMF 214, and Boyington was put in charge. In honor of their backdoor conception, the pilots decided to name themselves the Black Sheep. In deference to Boyington's age, they dubbed their commander Pappy.

In two combat tours, which lasted a total of 84 days, VMF 214 achieved an almost mythical record: 97 enemy aircraft destroyed, 11 Black Sheep lost.

As the squadron's intelligence officer, author Frank Walton had an overall (though second-hand) notion of each of its aerial fights. His recitation of the Black Sheep's achievements occupy the first half of the book. Here are fighter pilot yarns in the time-honored tradition, complete with the epithets, the bad food, the wild liberty in Australia, the improbable nicknames, the Japanese Zeros spilling out of the clouds, the search for the lost comrade. . . . They are good stories, and Walton's narration is better than most.

In the second half of his book, Walton switches from raconteur to philosopher, writing about the 34 surviving officers of the Black Sheep Squadron (but none of the several hundred enlisted men who kept them flying, an omission all the more grievous because he does include sketches of the two nonflying officers). The portraits are necessarily brief. Typically they include reflections on the terrors and joys of combat, praise for the unit and usually for its commander, and a sentence or two about the fliers' subsequent careers in fields including business, art, and covert operations. Most are accompanied by two photographs, one depicting the young eagle of 1943, the other revealing the old bird of the 1980s. Often the contrast is painful, and never more so than with Boyington. His face shows every mile of the path he has traveled—combat ace, prisoner of war, Medal of Honor winner, alcoholic, and finally stand-up entertainer at air shows and conventions, where he supplements his fee by selling his autobiography.

"And that's what this combat pilot who had been the scourge of the Japanese in the South Pacific has come to," writes Walton, a man betrayed by the hero of his youth. "Like a dancing bear, he's an entertainer."

—Daniel Ford lives in New Hampshire, where he is working on a book about the Flying Tigers.

Beyond Spaceship Earth. *Edited by Eugene C. Hargrove. Sierra Club Books, 1987. 352 pp., b&w and color illustrations, $25 (hardbound). Available in bookstores after March 1, or by order (add $4.50 for postage and handling) from the Sierra Club Store, 730 Polk St., San Francisco, CA 94109, (415) 923-5600.*

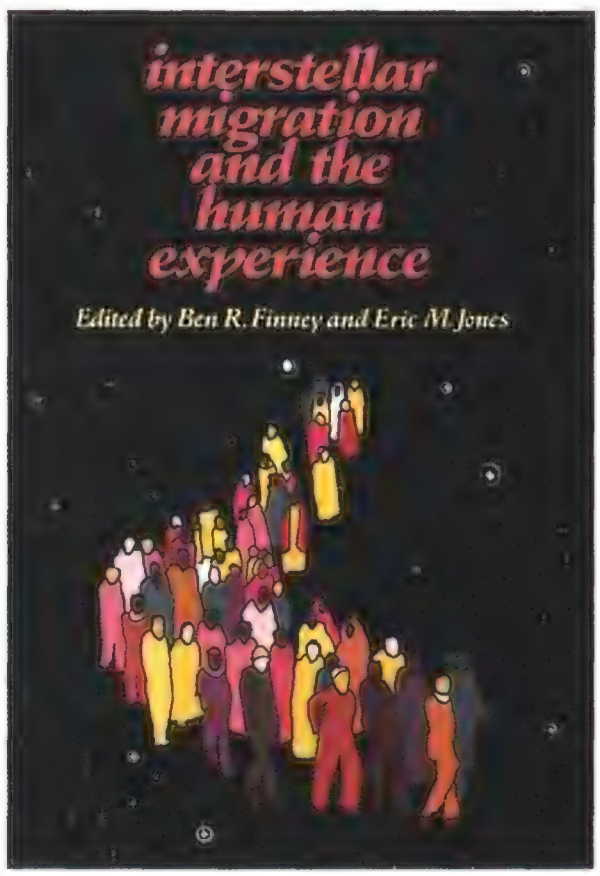
Interstellar Migration and the Human Experience. *Edited by Ben R. Finney and Eric M. Jones. University of California Press, 1985. 354 pp., b&w illustrations, $32.50 (hardbound), $9.95 (paperback).*

Envoys of Mankind: A Declaration of First Principles for the Governance of Space Societies. *By George S. Robinson and Harold M. White Jr.; prologue by Gene Roddenberry. Smithsonian Institution Press, 1986. 292 pp., $19.95 (hardbound).*

Suppose you were a crew member on an intergalactic spaceship setting out on a 400-year-long voyage. You yourself would never reach the craft's destination—only your distant descendants would. For four centuries, each generation would be effectively imprisoned on the spaceship. They would travel toward a destination chosen by their ancestors, doomed to live out their lives in their self-contained environment and reproduce so that their descendants eventually could explore or populate a new world. Would such a voyage be morally permissible?

If questions such as this have ever kept you awake at night, you can now rest assured that you are not alone. Even strangers to such speculation may be intrigued by one or more of three new books—*Beyond Spaceship Earth, Interstellar Migration and the Human Experience,* and *Envoys of Mankind.*

Each book offers readers a glimpse of some of the issues involved in the evolution of mankind into "spacekind." It is ironic that these books should come out at a time when the United States is incapable of launching even one human into space, much less the foundations of an entire society. But perhaps the timing is strangely



appropriate, for it may be that we are best able to step back and evaluate the broad contour of humanity's future in space now, when we are not focusing on the fine delineations of a busy space program.

Beyond Spaceship Earth and *Interstellar Migration and the Human Experience* both consist of a series of essays on topics ranging from space industrialization to the possible physical and psychological effects of long-term space habitation, from the probability of finding extraterrestrial intelligence to what we should do when we find it—or it finds us. These essays are written by such experts as planetary scientist William Hartmann and science fiction writer David Brin (both of whom contributed to both books), astronomer Carl Sagan (in *Interstellar*), and President Kennedy's secretary of state, Dean Rusk (in *Spaceship*). On an essay-by-essay basis, there is little to distinguish the two books, but in their entirety they have very different emphases and tones.

Of these two books, the Sierra Club's *Beyond Spaceship Earth* is more eclectic, and should be more broadly appealing. It does not shy away from presenting strong arguments against either space exploration in general or specific space utilization proposals. In light of the Sierra Club's interests, it's not surprising that *Beyond Spaceship Earth* is one of the few forums for articulate, well-reasoned discussions of the potential effects of man's activities in space on the extraterrestrial environment. These discussions include a statistical analysis of the size and composition of debris already found in Earth orbit.

The book also addresses some of the issues raised by the prospect of "terraforming," altering a planet's atmosphere and other physical characteristics to make it more Earth-like and therefore more hospitable to humans. All too often, space enthusiasts assume that their beliefs about the desirability of terraforming or other space activities are widely shared, without recognizing that these ideas are ethically or even theologically troublesome to many people. *Beyond Spaceship Earth* does not presume to resolve such issues, but it at least presents readers with informed opinions from a variety of viewpoints.

Interstellar Migration and the Human Experience clearly wins the best-title award. Unfortunately, the book tends to get bogged down in speculation on the details of establishing human habitations in space, details that are unlikely to become causes for practical concern for at least another few decades. For example, the question of just how many founders would be needed to start a viable, self-perpetuating human community without danger of inbreeding hardly demands an immediate reply.

To its credit, *Interstellar Migration* does offer some interesting insights on the idea of "colonizing" space. Understandably, the very idea of space colonization is at best unappealing to most citizens of the Third World and to many American Indians. Is the

desire to explore, develop, and exploit space just the natural outgrowth of traditional Western imperialism and expansionist doctrine? The book's editors argue against this interpretation, but the question is clearly not easily answered.

Envoys of Mankind is written by two lawyers specializing in space law and space industrialization, George S. Robinson and Harold M. White Jr., which explains the book's focus on the legal issues relating to long-term human space habitation. Fortunately, their conception of these legal issues is broad enough to take political and philosophical questions into account. Even so, while closet legal eagles will love it, the book will probably interest only a relatively small audience.

But back to that 400-year-long spaceship voyage you were considering: it *would* be morally permissible, at least according to Edward Regis Jr. in *Interstellar Migration.* He argues that Earth's children, too, are born into a self-contained world, and into conditions determined by the actions of their ancestors. "A multigenerational interstellar expedition," Regis writes, "is no more and no less morally permissible than the very existence of human life on our own planet."

—Katie Janssen

America's Achievements in Space, Volumes I and II. *The Easton Press, (800) 243-5160. Videotapes available only by subscription to series of 10 volumes. $29.95 plus $2.50 postage and handling per cassette.*

Despite its recent setbacks, the American space program has had an admirable series of successes. So at first glance it seems like the Easton Press had a good idea with *America's Achievements in Space,* a series of videotapes offered on a subscription basis. Despite the implied jingoism, it sounds like an interesting package. Every two months subscribers receive a set—two videotape volumes—of the series' 10 volumes. Each volume runs around 90 minutes and contains short films on two or three subjects. For example, Volume II contains segments about Apollo 8, Gemini 4, and Mariner 9. "You will see it all," astronaut Jim Lovell tells us in his introduction to the series.

Unfortunately, the execution fails to live up to the concept. What the *America's Achievements in Space* series really consists of is a collection of repackaged National Aeronautics and Space Administration documentaries made around the time of each mission. The section on

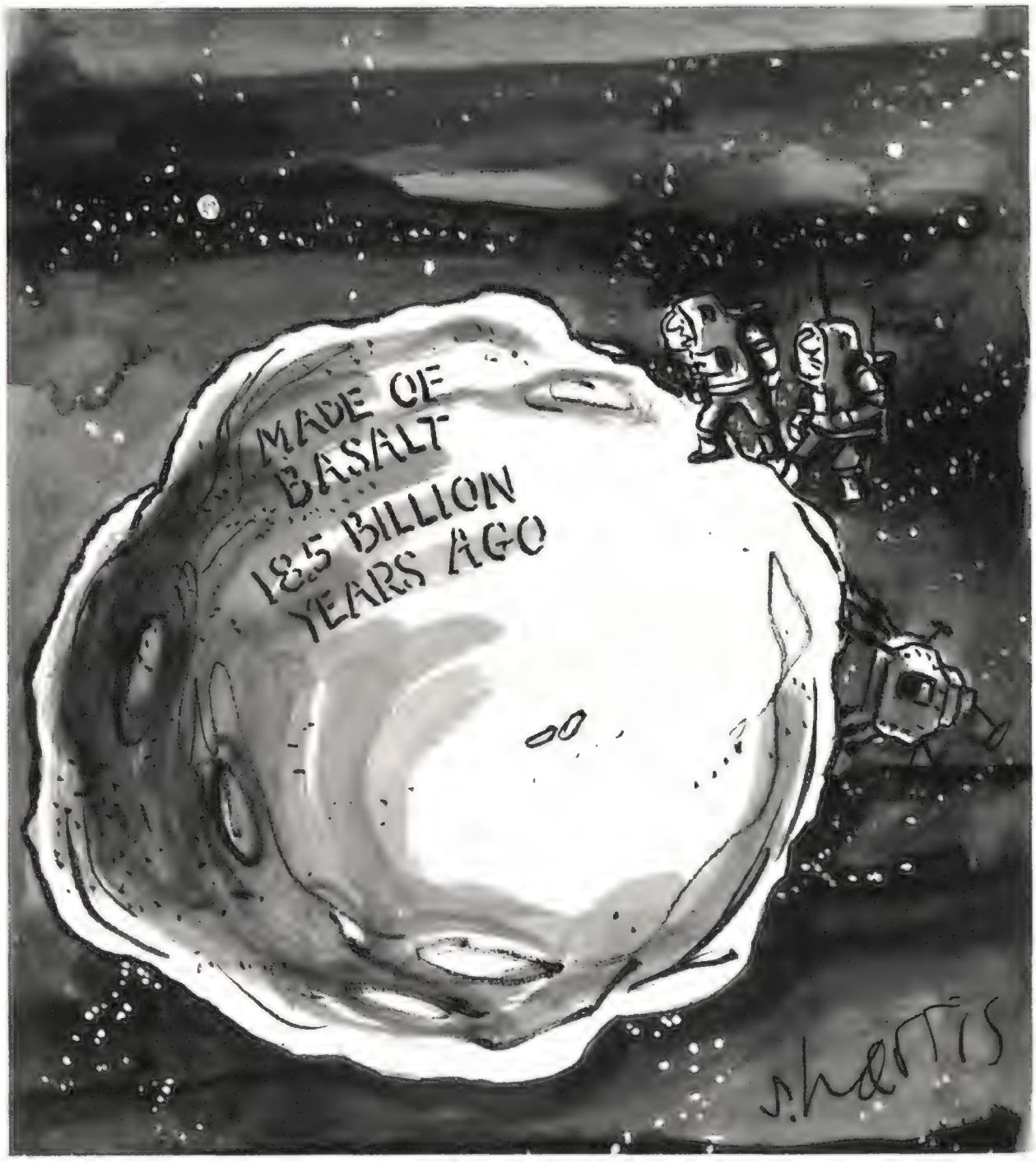
John Glenn, titled "Friendship 7," was made in the early '60s; the Mariner 9 video in the early '70s. When Carl Sagan mentions in the Mariner segment that "in 1976 Viking orbiters will place landers on Mars," most viewers will be all too well aware that this did happen, more than 10 years ago.

NASA's role as producer of this material at least explains the focus on America's achievements. And NASA's on-the-scene reportage explains the weird stylistic jumps between segments. The first one, "New View From Space," attempts a hip approach, complete with a jazz score, to the subject of NASA photography. In contrast, "Friendship 7" takes such a sanctified look at John Glenn's flight that it seems surprising the man wasn't canonized upon splashdown. "Today John Glenn and the Mercury team challenged space . . . and they won," intones the narrator. The soundtrack music seems designed to emphasize that this victory was more important than one on "Wheel of Fortune"—though not, as presented here, more exciting.

Some of the first set's footage does make for fascinating viewing, but the lack of historical context becomes frustrating: for example, the Gemini 4 segment, which concentrates on Ed White's space walk, was produced before his death in the Apollo 1 fire and therefore doesn't mention this tragic epilogue; and many of the Mariner video's speculations about life on Mars are now superfluous in light of the Vikings' discoveries.

The sole material produced especially for this series is the introductory material by Lovell, which comes off like a commercial. That leaves only stale NASA documentaries, which work better as historical documents than as entertainment. Subscribers hoping for an organized and up-to-date overview of the American space program are bound to be disappointed with this patchwork series.

—Tom Huntington



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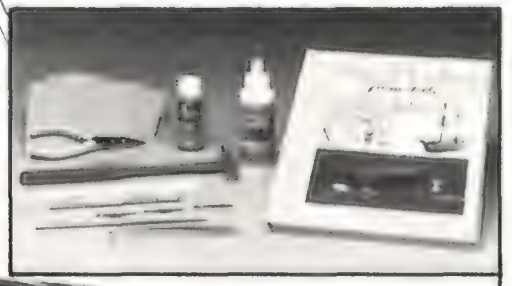

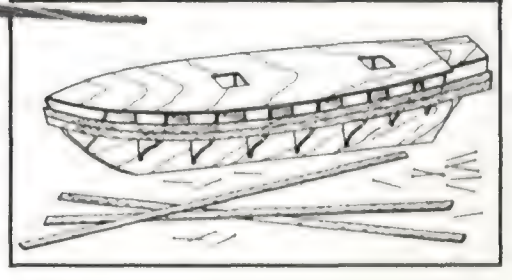

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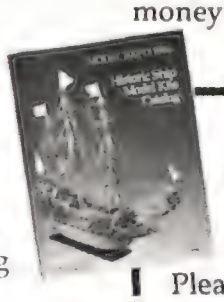

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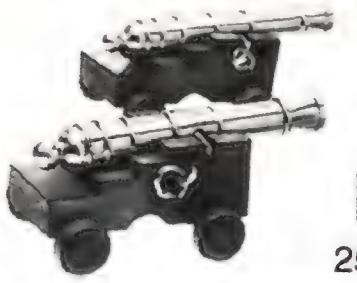

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Credits & Further Reading

On the Wings of the Garuda. Phil Cohan, a freelance writer, is a former Washington newsman and a veteran of the United States foreign service. His last work for *Air & Space/Smithsonian*—"Hello? Hello?"—appeared in the October/November 1986 issue.

Further information: *Emerging Indonesia* by Donald Wilhelm (Cassell, London, 1980).

"To Make the Moon More Beautiful." Patricia Trenner is an associate editor at *Air & Space/Smithsonian.*

Further information: *All-American Boys* by Walter Cunningham (Macmillan, New York, 1977).

The Little Airline of the Lake. Margaret Engel, a reporter for the *Washington Post,* is also an author and columnist whose subjects range from health care to regional American foods.

Further information: *Lonz of Middle Bass* by Henry M. Barr (the Delmar Printing Co., Charlotte, NC, 1982).

Clearing the Sky. John H. McElroy is director of special projects for the Government Systems Division of the Hughes Aircraft Company's Space and Communications Group. Hughes is a partner in the EOSAT joint mission. Before joining Hughes, he was an assistant administrator for the National Oceanic and Atmospheric Administration. From 1966 to 1982 McElroy worked for NASA in various positions, including deputy director of the Goddard Space Flight Center.

Further information: *Earthwatch* by C. Sheffield (Macmillan, New York, 1981).

Soaring on the Sea. John Rousmaniere has written and edited 13 books on sailing and the water, including *"Fastnet, Force 10"* (W.W. Norton, New York, 1980), *The Annapolis Book of Seamanship* (Simon & Schuster, New York, 1983), and *The Golden Pastime: A New History of Yachting* (W.W. Norton, New York, 1986). A racing and cruising sailor, Rousmaniere is also a columnist for *Yachting* magazine.

Further information: *Aero-Hydrodynamics of Sailing* by C. Marchaj (Dodd, Mead, New York, 1979).

Desirable and Undesirable Characteristics of Offshore Yachts, edited by John Rousmaniere (W.W. Norton, New York, 1986).

Face Value. Carl A. Posey is a private pilot, novelist, and student of airplane faces. He lives in Tucson, Arizona, and writes frequently on science and aviation. His latest novel, *Red Danube,* was published by St. Martin's Press in August 1986.

Further information: *An Illustrated Guide to the World's Civil Airliners* by William Green and Gordon Swanborough (Arco Publishing, Inc., New York, 1982).

All Quiet on the Launch Pad. Fred Reed is a syndicated military columnist with Universal Press. He has also written on military and general subjects for *Harper's* and *National Review.* His last article for

Air & Space/Smithsonian, "The Electric Jet," appeared in the December 1986/January 1987 issue.

Further information: *Moonport: A History of Apollo Launch Facilities and Operations* by Charles D. Benson and William Barnaby Faherty (U.S. Government Printing Office, Washington, DC, 1978, stock no. 3300-00740-0).

The Search for *L'Oiseau Blanc.* Stephan Wilkinson has crossed the Atlantic twice in light airplanes, once as a participant in the 1969 London *Daily Mail* Great Atlantic Air Race, in which his was the fastest crossing by a nonjet aircraft. Still, he had a closed cockpit and two engines, and his admiration for Nungesser and Coli, he says, is thus boundless. His last article for *Air & Space/Smithsonian* was "Space Geniuses Wanted: Apply JPL," in the December 1986/January 1987 issue.

Further information: *1927: Summer of Eagles* by Jack Huttig (Nelson-Hall, Inc., Chicago, 1980).

Atlantic Fever by Edward Jablonski (Macmillan, New York, 1972).

To contact TIGHAR write to Box 424, Middletown, DE, 19709.

The Methuselah Project. Jack Fincher has been the San Francisco bureau chief for *Life* magazine and a contributing editor to *Human Behavior.* His books include *Human Intelligence,* for which he won the American Medical Writers Association award in 1977. His freelance articles have appeared in *Smithsonian, McCall's,* and many other publications.

Further information: *Was Einstein Right?* by Clifford M. Will (Basic Books, New York, 1986).

Einstein's Universe by Nigel Calder (Viking Press, New York, 1979).

Taking the High Road. Joe Allen is the executive vice president of Space Industries, Inc., of Houston, Texas. An astronaut from 1967 to 1985, he was a crew member on the space shuttle's first operational mission and the first space salvage mission. He also co-authored *Entering Space: An Astronaut's Odyssey* with Russell Martin (Stewart, Tabori & Chang, New York, 1984).

Healthy Skies. Jake Page is a hypochondriac. His next book, about the National Zoo, will be published by the Smithsonian Press.

A Gift of Flight. Gary A. Michel is the chief of the Airworthiness Law Branch of the Chief Counsel of the Federal Aviation Administration. He lives in Maryland.

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In the Wings . . .

Christopher Springmann

The Swedish Air Force—In a nation noted for experimenting with the social order, the air force is not exempt. What's more intriguing is how a country that practices strict neutrality bears the cost of developing its own fighters and then deploying them as if it were on the brink of war (above).

UFOs as Pilots See Them—When the people who see lights in the sky are up in the sky themselves, the observations are often seen in a new light. Pilots' reports of UFOs are not explained away easily, though some analysts say that the mere fact that they're pilots disqualifies them as reliable eyewitnesses.

Space Tourists—People have plunked down deposits for a trip to orbit the Earth as if it were as simple as going on a cruise. Their reasons for forking over hard-earned money to a space tourism company are as varied as their lives and personalities. What are *you* doing on your next vacation?

Peter Menzel

Base Jumpers—Some people! Give them a parachute and a bridge to jump from, and . . . well, don't stand underneath. As if jumping from any handy tall structure weren't enough, they even dress funny.

Special Insert—

The Satellite Sky

Amateur satellite trackers say that all you have to do is watch the sky for about an hour before sunrise or after sunset and you'll see several satellites winking from their orbits. Since the first *Sputnik* was launched in 1957, the world has lofted hundreds of "artificial moons" into the heavens.

Coming in Volume 2

A special insert in the first anniversary issue of *Air & Space/Smithsonian* charts the known active satellites that currently orbit the Earth.

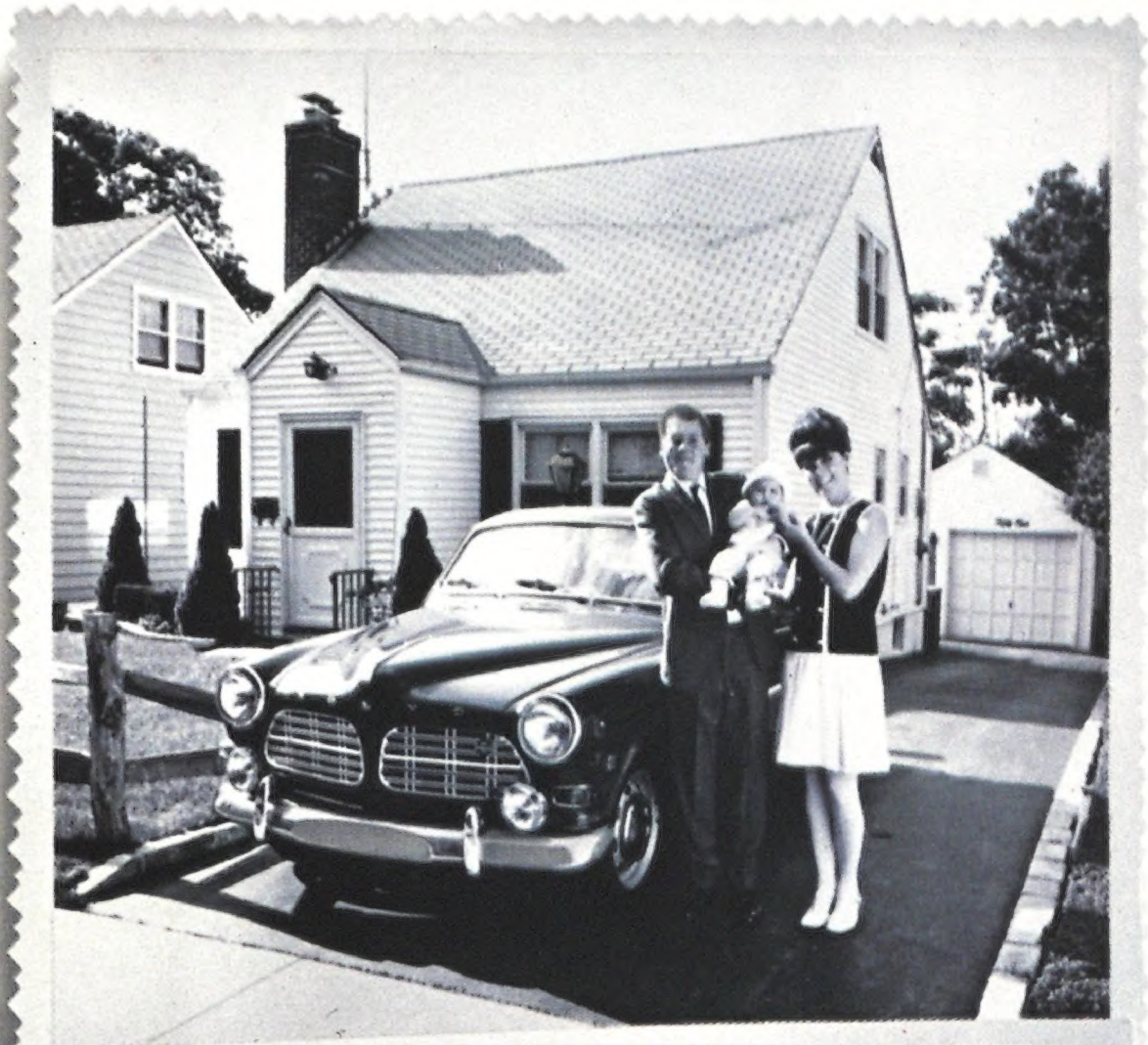
This 21- by 33-inch poster depicts hundreds of objects by name, with the country operating the satellite, the date of its launch, and the name of the space center that launched it clearly shown.

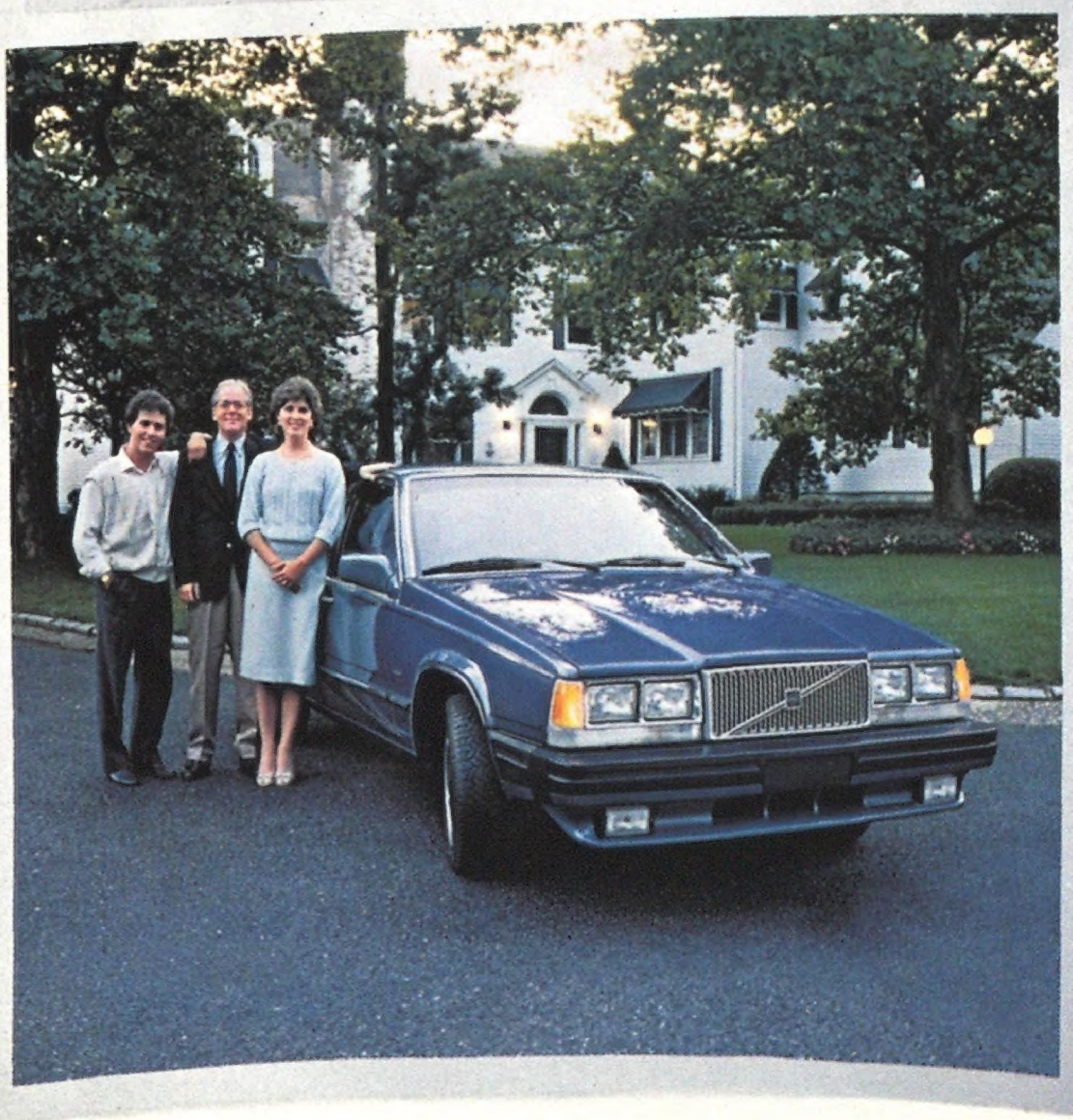
At a glance, the enormity and diversity of the world's orbiting resources can be seen arranged by orbital altitudes, from low orbit to geosynchronous orbit, in this spectacular map.

Communication satellites, surveillance satellites, and many more are charted here, many for the first time anywhere. And accompanying this special one-time insert is a feature article about satellite tracking—who does it and how.

Plus: Updates on launches in future issues will enable *Air & Space/Smithsonian* readers to maintain their Satellite Sky wall charts with the most current information available. So this bonus insert will continue to entertain and educate for years to come!

THE CAR FOR PEOPLE WHOSE MEANS HAVE CHANGED BUT WHOSE VALUES HAVEN'T.





Back when you had precious little in the way of means at all, you may have been one of those pioneering souls who bought a Volvo.

It was the perfect family car. Spartan? Perhaps. But also very sensible. A Sherman tank with room for six. And a growing reputation for durability and safety.

Both of us have come a long way since then.

You, for example, may have reached that point in life where you view a car not as a necessity so much as a reward.

And we have reached a point where we can create a car like the Volvo 760 Turbo.

A car that surrounds you with every comfort a person of means could want in a car. A turbo-charged phenomenon capable of embarrassing cars much more famous for performance.

Admittedly, the Volvo 760 Turbo is an indulgence.

But underneath you'll discover it's still a Volvo. A totally sensible car with an enviable reputation for durability and safety.

A car that lets you indulge your senses.

Without taking leave of your sense.

VOLVO

A car you can believe in.

Complete your set.

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If you're traveling across the Pacific, flying the friendly skies can be a great way to build your coin collection—or just build a collection of great memories.

United can take you to thirteen Pacific cities from all 50 states. More fascinating destinations over there from more cities over here than any other airline in the world.

Best of all, when you choose United's Royal Pacific Service, you've got a friend with you every step of the way.

To start your collection, just call your Travel Agent. Or call United. It could be the start of a lifelong hobby.

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